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OPERATION AND MAINTENANCE MANUAL
EDWARD ALLEN LANDFILL
CORNING, NEW YORK

VOLUME 1

By
Haley & Aldrich of New York
Rochester, New York

For
Edward Allen Landfill
Corning, New York

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CERTIFICATION PAGE FOR

OPERATION AND MAINTENANCE MANUAL
EDWARD ALLEN LANDFILL
CORNING, NEW YORK

PREPARED FOR
EDWARD ALLEN LANDFILL
CORNING, NEW YORK

I, James E. Siegfried, certify that I am currently a New York State registered professional engineer and that this Operations and Maintenance Manual was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10).

This Operations and Maintenance Manual has been submitted for the continual and proper operation, maintenance, and monitoring of the institutional and engineering controls employed at the site including the proper maintenance of any remaining monitoring wells, and that such plan has been approved by the NYSDEC.

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10/19/2021

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Document Change Log

This change log is used to track all approved changes made to this document after initial approval. Changes will be identified here upon approval of the New York State Department of Environmental Conservation.

Revision Date	Status	Section(s) Affected	Description of Revision	Author
1/2002	Approved	3.2.2	Revise some components of semi-annual groundwater sampling program to annual sampling program	Fagan
6/2008	Approved	Appendix C	Eliminate Radiological Testing from Groundwater Monitoring	H&A
6/2008	Approved	3.4	Eliminate surface water monitoring	H&A
6/2008	Approved	3.2.2 (& 3.6 by reference)	Revise remaining components of semi-annual groundwater sampling program to annual sampling program	
9/2018	Approved	N/A	Modification of Well Sampling Method to Low-Flow Sampling (via attachment)	H&A
10/2021	Approved	N/A	Added Certification Page	H&A
10/2021	Approved	1.2.4	Incorporate Description of Engineering Controls	H&A
10/2021	Approved	1.2.5	Addition of Certification language	H&A
10/2021	Approved	2.0 (various)	Revise to reflect the current (post-closure) state of the landfill, removed references to temporary facilities in place during construction.	H&A
10/2021	Approved	2.2 (various)	Revise controls description to include description and procedures of new remote monitoring and alarming system.	H&A
10/2021	Approved	2.2.6	Revise disposal locations, methods, and testing requirements	H&A
10/2021	Approved	3.2.3	Incorporate Low-Flow Sampling into Manual	H&A
10/2021	Approved	3.3	Added “Modifications to Monitoring” Section	H&A
10/2021	Approved	3.5.2	Revise air monitoring frequency to match current requirements	H&A
10/2021	Approved	4.10 and various	Revise contacts and entity names.	H&A
10/2021	Approved	Appendix A	Revise equipment manuals with new controls equipment.	H&A
10/2021	Approved	Appendix B	Revise Health & Safety Plan to meet current requirements and standards.	H&A

1. Introduction

This manual has been prepared for the Edward Allen Landfill Potentially Responsible Parties (PRP) Group, consisting of Corning Incorporated, ViacomCBS Inc., (formerly CBS Corporation), and Mr. Edward Allen, as a means of providing guidelines and procedures for operation and maintenance (O&M) and monitoring of the Edward Allen Landfill during the post-closure period. This document supplements information contained in the various manufacturers' O&M publications and shop drawings, Contract Documents (including technical specifications and record drawings) and the Final Remedial Design Report, which are all separately bound appendices. A three-ring binder (on-Site only) and PDF formats are provided so that updates of this O&M Manual may be made as conditions warrant during continuing operations.

1.1 PROJECT DESCRIPTION

The Edward Allen Landfill (Site) is an inactive municipal waste landfill located in the Town of Corning, New York. The landfill, owned and operated by Mr. Edward Allen, reportedly received municipal and industrial waste between 1953 and 1979 and covers approximately 27 acres. The New York State Department of Environmental Conservation (NYSDEC) conducted Phase I and Phase II investigations at the Site in 1983 and 1985, respectively. In August 1987 Corning Glass Works (now Corning Incorporated) and Westinghouse Electric Corporation (now ViacomCBS, Inc.) entered into an Order on Consent (#B8-0015-84-01) with NYSDEC for performance of a Remedial Investigation/Feasibility Study (RI/FS). The RI Report was completed in November 1990 and approved by NYSDEC in June 1991. The FS was submitted to NYSDEC in October 1991.

In March 1992, NYSDEC issued a Record of Decision (ROD) presenting the selected Remedial Action Plan (RAP) for the Site. The ROD is contained in Attachment 1 to Volume 2 of this manual.

In February 1993, the PRP Group entered into an Order on Consent (#B8-0015-91-07) with NYSDEC to implement the RAP presented in the ROD. The February 1993 Order on Consent is contained in Attachment 2 to Volume 2 of this manual.

Following submittal and NYSDEC review of the Preliminary Remedial Design Report in April 1993, it was agreed between the PRP Group and NYSDEC that the design had progressed to a point which allowed for the completion of the Final Remedial Design, which was issued in April 1994. Volume 2 of this report contains the separately bound Final Remedial Design Report (revised April 1994), Contract Drawings, Contract Documents (Specifications) and the Subsurface Investigation Report represent the Final Remedial Design.

The Site remediation project, designed by O'Brien & Gere Engineers, Inc., and constructed in 1994 and 1995 by O'Brien & Gere Technical Services, Inc., includes the following major components:

- A synthetic cover and gas venting system designed and installed in accordance with the technical requirements of 6 New York Code of Rules and Regulations (NYCRR) Part 360.
- A circumferential seepage collection trench to collect generated seepage. The collected seepage is stored in on-Site underground storage tanks and periodically removed for off-Site treatment.

- A surface water drainage ditch installed to intercept and direct surface water away from the landfill.
- A groundwater monitoring system: consisting of piezometers installed within the limits of the landfill and ground water monitoring wells installed exterior to the limits of the landfill to monitor ground water elevation and ground water quality.
- A chain link fence installed around the Site to limit access, with access roads and gates.

1.2 SUMMARY OF O&M ACTIVITIES

1.2.1 General

Post-closure operation, maintenance and monitoring of the Edward Allen Landfill does not effectively occur without the continuous efforts of the PRP Group.

1.2.2 O&M Activities

Operation and maintenance of the Edward Allen Landfill during the post-closure period is the responsibility of the PRP Group. Operation and maintenance activities to be performed by the PRP group include:

- Routine inspection and maintenance of the low permeability cover, the seepage collection and storage system, the Site drainage system, the physical Site security system, the access road, the gas vents, and the groundwater monitoring system.
- Perform groundwater, air (landfill gas vents) and homeowner drinking water well sampling programs, as scheduled.
- Procure and coordinate work to be performed by analytical testing laboratories and other subcontractors.
- Respond to alarm conditions and unforeseen occurrences affecting the proper operation of the facility, identify of the condition which occurred, take steps to mitigate the alarm/occurrence and take steps to prevent future occurrences.
- Coordinate removal of seepage from storage tanks.
- Troubleshoot and perform diagnostic service, as required.
- Evaluate operation, maintenance and monitoring activities and identify proposed changes to the O&M Manual or Site procedures/policies which would provide a safer and/or more cost-effective operation.
- Maintain a detailed log of operation, maintenance and monitoring activities.
- Evaluate data for consistency with applicable long-term performance criteria.
- Maintain personnel records.

The personnel assigned to operate the landfill shall be required to meet and maintain current medical surveillance and personnel training requirements identified in the Site Health and Safety Plan contained in Appendix A.

1.2.3 Institutional Controls

The PRP Group is responsible for monitoring and enforcing institutional controls at the Site during the post-closure period. The institutional controls are in place to protect the integrity of the landfill and the safety of those who come in contact with it. If necessary, the PRP Group will request assistance from NYSDEC with enforcing the institutional controls.

Institutional controls at the landfill include the following:

- Site Access Restrictions;
- Groundwater Use Restrictions;
- Groundwater and Gas Vent Monitoring Program; and,
- Deed Restrictions for the landfill and surrounding properties.

1.2.4 Engineering Controls

The PRP Group is responsible for monitoring and maintaining engineering controls at the Site during the post-closure period. The engineering controls are in place to protect the integrity of the landfill and the safety of those surrounding the landfill, or who may come in contact with it.

Engineering controls at the landfill include the following:

- Low Permeability Cap;
- Seepage Collection and Storage System;
- Site Drainage; and,
- Site Security and Access.

1.2.5 Certification of Controls

Within 30 days after the end of each certifying period, as determined by the NYSDEC, the following certification will be provided to the Department:

"For each institutional or engineering control identified for the Site, I certify that all of the following statements are true:

- *The inspection of the Site to confirm the effectiveness of the institutional and engineering controls required by the Operation and Maintenance Manual was performed under my direction;*
- *The institutional controls employed at this Site are unchanged from the date the controls were put in place, or last approved by the Department;*
- *Nothing has occurred that would impair the ability of the controls to protect the public health and environment;*
- *Nothing has occurred that would constitute a violation or failure to comply with the Operation and Maintenance Manual;*
- *Access to the Site will continue to be provided to the Department to evaluate the remedy, including access to evaluate the continued maintenance of this control;*

- *Use of the Site is compliant with the Deed Restriction;*
- *The engineering controls as described in the Operation and Maintenance Manual are in place and remain effective during the reporting period;*
- *To the best of my knowledge and belief, the work and conclusions described in this certification are in accordance with the requirements of the Operation and Maintenance Manual and generally accepted engineering practices; and,*
- *The information presented in this report is accurate and complete.*

I certify that all information and statements in this certification form are true. I understand that a false statement made herein is punishable as a Class "A" misdemeanor, pursuant to Section 210.45 of the Penal Law, I, [name], of [business address], am certifying as [Owner or Owner's Designated Site Representative] (and if the Site consists of multiple properties): and I have been authorized and designated by all Site owners to sign this certification for the Site."

1.3 REQUIREMENTS FOR UPDATING THE O&M MANUAL

This O&M Manual may require modification or enhancements as a result of data generated, when more cost effective or better procedures are identified or developed by operations personnel who apply the O&M Manual. As stated in Section 1.0, the three-ring binder format is provided in order that changes to this Manual may be facilitated as conditions warrant.

To comply with NYSDEC procedural requirements, potential changes to this O&M Manual identified by operations personnel shall first be described or discussed in detail with the PRP Group. If appropriate, the recommended change shall be identified by the PRP Group to NYSDEC for its approval. Once approved by NYSDEC, copies of revisions to the O&M Manual shall be forwarded to holders of the O&M Manual for insertion into their respective copies. NYSDEC-approved changes/revisions shall then become operational requirements.

2. Post-Closure Site Maintenance Activities

The following section identified the major components of Site remediation, and the maintenance requirements for each.

2.1 LOW-PERMEABILITY COVER

2.1.1 Description

The low permeability synthetic cover system installed at the Edward Allen Landfill consists of the following layers, from the bottom up:

- *Gas venting layer:* The gas venting layer consists of a double-bonded geonet. The geonet serves both as a gas venting layer as well as a seepage collection layer for surface seeps. Twenty-four passive gas vents are tied into the gas venting layer to allow any generated gas to escape.
- *Barrier layer:* The barrier layer consists of a 40-mil thick, very low-density polyethylene (VLDPE) geomembrane with a maximum permeability of 1×10^{-12} cm/sec.
- *Barrier protection layer:* A 24-inch-thick soil protection layer is installed over the VLDPE barrier layer. The barrier protection layer serves to protect the VLDPE geomembrane from external forces such as frost action, root penetration and erosion.
- *Topsoil:* Six inches of topsoil is placed above the barrier protection layer. The topsoil and all areas disturbed during construction was seeded. Vegetation was established to minimize the erosion on the side slopes.

2.1.2 Purpose

The low permeability synthetic cover system was installed over the landfill to minimize direct contact with the waste and to reduce the amount of seepage being generated by the infiltration of incident precipitation.

2.1.3 Inspection and Maintenance Requirements

Routine inspections of the closed landfill and immediately adjacent areas are performed monthly. During these inspections, the inspector will observe the condition of the vegetative cover. Should areas of settlement, erosion, or slope instability be noted, regrading and/or restoration will be conducted to promote drainage, minimize erosion, and to minimize the percolation of water into the landfill.

Periodic mowing of the vegetated cover will be performed as needed to maintain satisfactory runoff, and to retard the establishment of deep-rooting shrubs, brush or trees on the cover. If visual observation indicates that deep rooting vegetation has been established on the cover inside the perimeter seepage collection system, a program to control this vegetation will be implemented. The routine cover inspection should also note problems with thinning of vegetation. Areas which appear to be thinning out over time will be overseeded to keep the vegetative cover uniform.

2.2 SEEPAGE COLLECTION AND STORAGE SYSTEM

2.2.1 Description

A seepage collection system was installed along the entire perimeter of the landfill between the regraded toe of the waste and the toe of the final cover. The collection system consists of perforated 6-inch diameter polyethylene piping installed in a trench with the pipe invert occurring between 3.5 and 18.5 feet below finished grade. The gas venting layer is tied into the seep collection trench so that surface seeps will be transmitted through the gas venting layer into the collection trench. The pipe trench below the gas venting layer is backfilled with permeable stone.

The perforated seep collection pipeline is sloped bi-directionally from the high point (Manhole #12) to Manhole (MH) #5. The section from MH #12 extending along the southwestern edge of the landfill is approximately 2,200 feet long, whereas the section extending along the northeastern perimeter is approximately 2,100 feet long.

Collected seepage flows by gravity through the collection system piping with a minimum slope of 0.007 feet per foot. Manholes are installed along the seep collection system at major changes in grade or direction to permit inspection and cleaning of the seepage collection system piping.

From the exit point MH #5, leachate continues to flow by gravity through a solid 6-inch HDPE carrier pipe, contained within a 10-inch diameter HDPE secondary containment pipe (normally dry), to the emergency shut-off valve vault. At the emergency shut-off valve vault, the secondary containment is terminated to accommodate the 6-inch diameter motor operated pinch valve contained therein. A sump with a stem type float switch is provided in the emergency shut-off valve vault to detect leaks that occur in the piping upstream or within the emergency shut-off valve vault. The signal from the float switch is sent to the main monitoring panel.

With the emergency (pinch) valve in its normally open position, the seepage is directed by gravity through a 6-inch primary / 10-inch secondary solid HDPE containment piping to the valve vault which contains valves and piping arranged to provide directional flow control to the two 15,000-gallon, buried, double-walled, horizontal storage tanks located near the landfill entrance.

The emergency pinch valve is automatically closed when the level in one or both storage tanks reaches the high level (approximately 100% of tank capacity), as measured via a level sensor in each of the tanks and transmitted to the main monitoring panel. When the emergency (pinch) valve is in the closed position, seepage builds up in the solid seepage collection pipe towards MH #5, to decrease the potential for the tanks to overflow.

Similar to the emergency shut-off valve vault, secondary containment piping is terminated at the inside wall of the valve vault on both upstream and downstream piping with a sump and leak sensor (float switch) sending a signal to the main monitoring panel.

The piping leading from the valve vault to the buried tanks is secondarily contained, with secondary containment being terminated at the tanks within the secondary containment chambers, extending from grade to the underside of the tanks. Piping connected to the tanks, except tank interstitial monitoring piping, is connected to tank manhole lids within secondary containment chambers. Leak sensors are provided within the secondary containment chamber of each tank, with signals transmitted

to the main monitoring panel. Piping within each chamber is single walled, but the pipes leaving each tank are contained within double walled piping systems with the transition from single walled to double-walled occurring within the secondary containment chamber and above grade.

Each tank is equipped with a three-inch fill line, a three-inch line tying the tops of the two tanks together (with a shut-off); a continuous liquid level monitor, a three-inch vent line, a four-inch manual gauging station; and interstitial monitor for monitoring the interstitial space between the inner and outer shells of the tank; and a three-inch withdrawal port.

The main monitoring panel, power panel, and cellular interface panel are located in the Electrical/ Instrumentation building. This building also contains light fixtures, conventional outlets and a unit heater.

2.2.2 Purpose

The seepage collection system was installed to collect seepage expressed as surface outbreaks, thus protecting the integrity of the cover and adjacent surface waters. The storage system provides a place to hold the collected seepage for periodic removal and disposal.

2.2.3 Inspection and Maintenance Requirements

The inspection and maintenance requirements associated with the seepage collection and storage system are as follows:

- *Seepage collection system*: The seepage collection system is to be inspected monthly for buildup of sediment or scale deposits in the transfer piping and at the manholes. In the event that any buildup is noticed, samples may be taken for laboratory analysis to evaluate the cause of the buildup. The thickness or extent of buildup should be closely monitored. Permit required confined space entry procedures (refer to Health and Safety Plan) shall be in effect with manhole entries deeper than 3'-0".

  In the event that solids or scale buildup compromises the flow in the collection system, a sewer cleaning contractor experienced in high pressure jetting of HDPE pipes shall be employed to eliminate the problem. Sewer cleaning services will be routinely scheduled, as appropriate, to manage undesirable buildup, should it continue to occur.

  In addition to routine monitoring for buildup, the visible segments of the seepage collection system may be video monitored to detect undesirable settlement (out of rounding) or degradation. In the event that pipe collapse or chemical degradation (swelling, softening or loss of material thickness) is noticed in the manholes or within the collection pipeline, pipe manufacturers and/or engineering consultants should be provided with pertinent information in order that appropriate corrective measures may be undertaken.

  Particular attention should be paid to the CPVC piping and valves contained in the system vaults, as CPVC is significantly less chemically resistant than HDPE. Each time the valve vault is entered, but not less than quarterly, the CPVC piping and valves shall be visually inspected for swelling and soft spots. Motor operated valves should be exercised to confirm that they are properly seating. In the event that chemical degradation is noted, CPVC pipes and valves should be replaced with a material more resistant to the compounds found to occur in the seepage over time.

The motor operated pinch valve shall be exercised at least quarterly to confirm that buildup inside the valve is being removed as the valve is exercised. The packing on valves and motor operators (where provided) shall be maintained in accordance with operation and maintenance manuals provided by the respective manufacturers.

- *Electrical and heating systems*: The electrical and heating systems will be functionally tested through all operating conditions at least quarterly.
- *Secondary containment/leak sensing systems*: The annular space between the outside wall of the carrier pipe and the inside wall of secondary containment entering (from upstream areas) the emergency valve vault, the valve vault and the tank secondary containment manholes must be clear and dry in order that leaks entering the containment piping will flow to the structure to which the piping is attached. Vault and tank secondary containment sumps should be clean and dry with float switches mounted such that they are near the bottom of their respective sumps/ containment chambers with adequate clearance to operate. To prevent false alarms, entrances into vaults and secondary containment chambers must be watertight. Tank interstitial monitoring sensors should be installed at the bottom of the interstitial space monitoring pipe and tested for operation. Testing for interstitial monitoring sensors is similar to testing for other leak sensing probes. The sensor cable entrance into the interstitial space monitoring pipe must be watertight.
- *Tank level monitor*: True tank seepage elevation can be ascertained through insertion of the tank gauging stock into the manual gauging station provided in the same manhole as the tank level monitor.

  CAUTION: If the storage tank is full and seepage is allowed to back up within the solid seepage leachate collection piping, sufficient head may build up to cause all tank access points to be under pressure. Although the tanks and piping are designed to withstand up to 30 psig (69 feet) of water column, measured from the bottom of the tank, opening the gauging cap or any pipes connected to the tank under this type of condition may cause severe personal injury and an uncontrolled release of seepage to the environment. Proper operation of the emergency pinch valve will decrease the chances of over-pressurization.
- *Manually/mechanically operated valves*: The tank withdrawal port quick disconnect valves have integral spring-loaded check valves which should be in the closed position unless the tanker truck adapter is mechanically connected, and the selector handle is rotated to the open position. The three-inch diameter manually operated ball valve, located in the valve vault that provides cross connection between the two tanks should be normally closed unless there is a reason for cross connection between the buried tanks. Proper seating of all valves shall be checked at least annually.

2.2.4 Alarm Response

The remote monitoring system is tied through a cellular modem into a central monitoring station. This monitoring station will log and record all data from the system, generate call outs in the case of alarms, and provide remote troubleshooting of all sensors in the system. The remote monitoring system is designed to allow monitoring of the seepage collection and storage system remotely via a computer. The system will also call out (via e-mail notification) on certain alarms. Alarms will be triggered for the following conditions:

- High or High-High level in seepage storage tanks (set at 6,750 gallons and 9,900 gallons, respectively);
- Water in the emergency valve vault;
- Water in the valve vault; and,
- Tank secondary containment water sensor.

Tank levels shall be monitored remotely on a regular basis. Monitoring frequency may vary depending on the season and recent rainfall. When the total stored seepage volume in the two tanks exceeds 6,000 gallons, the hauler shall be contacted to schedule removal of the seepage from the Site (see "Off-Site Seepage Management, below).

If the high-high level alarm is triggered (at 9,900 gallons), an alarm notification is sent. It is imperative at this time that seepage be removed from the tanks and the alarm reset.

It is the policy of the PRP group that immediately after acknowledging an alarm condition, the respondent will go to the Site to investigate the cause of and eliminate (in so far as practical) the alarm condition.

The operator shall identify at what time the alarm was responded to, the reason for the alarm, and corrective measure(s) undertaken to mitigate the alarm and prevent further occurrence.

2.2.5 Off-Site Seepage Management

The seepage generated by the landfill will be disposed off-Site at the Steuben County Landfill treatment plant (Steuben County) located in Bath, New York. As the tanks fill with seepage, the tanks can be monitored remotely. When the tank levels exceed 6,000 gallons (a typical truck size for the seepage hauler), the operator will make arrangements for the removal of seepage.

The seepage will be removed from the storage tanks and hauled by tanker truck to Steuben County.

A record of the quantity of seepage disposed of off-Site will be maintained by the operator.

Steuben County requires the seepage to be analyzed annually for:

- Toxicity characteristic leaching procedure (TCLP) volatile organic compounds
- TCLP semi-volatile organic compounds
- TCLP Resource Conservation and Recovery Act list metals
- TCLP Copper, Molybdenum, Nickel, Zinc & Iron
- Ammonia
- Biochemical oxygen demand
- Total cyanide
- Nitrate – Nitrite
- Total Nitrogen
- Oil & Gas
- Phenolics
- Total Phosphorous
- pH

2.3 SITE DRAINAGE

2.3.1 Description

The surface drainage system is designed to protect the cover from the peak discharge expected during a 25-year, 24-hour storm. Surface water will drain from the cover to adjacent areas as follows:

- The northeast side of the cover drains overland across the access road to the wetland northeast of the landfill.
- The southeast side of the landfill drains by overland flow across the access road to the storm water control channel installed at the toe of the landfill, adjacent to the access road.
- The surface runoff on the southwestern slope of the landfill flows overland to a surface water collection ditch on the landfill side of the access road. The collection ditch directs the flow to one of two 12-inch Culverts which discharges to the storm water control channel.
- The runoff from the interior "horseshoe" area of the landfill conveyed by ditches and culverts to Bailey Creek.

The storm water control channel was installed to collect runoff from both the landfill and the surrounding hillside in order to protect the cover from ponding or erosion. The channel will also serve to lower the ground water in the vicinity of OBG-4 in order to minimize the groundwater quantity entering the seep collection system. The lining in the channel is as follows:

- Station 0 + 00 - Station 4 + 50 Medium rip-rap
- Station 6 + 50 - Station 20 + 00 Rock filled gabion baskets
- Station 20+ 00 - Station 27 + 16 Light rip-rap

The channel will drain similarly to the previous drainage pattern, with the majority of the flow passing under Bailey Creek Road, through the 2' x 3' corrugated steel pipe (CSP) arch at the headwall near the entrance to the Site, and ultimately discharging to Bailey Creek.

2.3.2 Purpose

The Site drainage system was implemented to protect the cover from runoff during a storm or seasonal thaw and to lower the ground water to minimize the ground water quantity entering the seep collection system.

2.3.3 Inspection and Maintenance Requirements

Inspection of drainage facilities will be conducted at the same frequency as inspection of the landfill cover. Drainage facilities will be inspected for accumulation of debris, which may inhibit flow, and for excessive scouring, which may erode ditches and stream beds. If drainage facilities, such as culverts and ditches, have excessive debris or soil accumulation, it should be removed to maintain flow capacity. If excessive scouring is noted, channel protection, consisting of rip-rap and/or geosynthetic protection, shall be added to maintain the integrity of the channel bed.

2.4 PHYSICAL SITE SECURITY

2.4.1 Description

Access to the Edward Allen Landfill is controlled by a series of vehicle gates on the main access road, by a man gate located in the Southwest Corner and by a perimeter fence around the landfill. The gates and fence are six-foot high chain link type, topped with one-foot of barbed wire, with warning signs spaced at 50-foot intervals to discourage trespassers.

2.4.2 Purpose

The purpose of the physical Site security is to prevent unauthorized access to the landfill Site, for the protection of the Site components as well as personnel who may enter.

2.4.3 Maintenance Requirements

The integrity of the fence shall be inspected by walking the perimeter at the same frequency as the inspection of the landfill cover. The structural integrity of the fencing system shall be verified, and breaches or weaknesses shall be repaired.

2.5 ACCESS ROAD

2.5.1 Description

There are two types of access roads at the Edward Allen Landfill. The first is an asphalt paved T-shaped turnaround located at the buried seepage storage tanks. The turnaround was designed to allow a tanker truck to collect seepage from the storage tanks for transport to a wastewater treatment plant.

The second type of access road is the gravel road along the landfill perimeter. This access road was designed to allow access to the seepage collection system for maintenance and repair.

The gravel access road has grades of 10% or less and is sloped to drain away from the toe of the landfill. Curves on the road are designed with a minimum turning radius of 45 feet.

2.5.2 Purpose

The purpose of the access roads is to allow for easy access of Site maintenance personnel to the necessary portions of the landfill, including traffic for Site inspections, seepage management, groundwater monitoring, and other landfill inspection and maintenance activities.

2.5.3 Maintenance Requirements

The access roads should be inspected at the same frequency as the low permeability cover system. The inspector should walk the access road and look for rutting, potholes or settlement. Should these conditions be observed, they will be corrected by filling with appropriate material. During the winter, the road will be plowed as needed to facilitate access for leachate removal, for inspection of the seep collection system and surface water control channel, and for routine sampling of ground water

monitoring wells. Snowbanks resulting from plowing will be arranged to promote off-Site drainage when thawing occurs.

2.6 GAS VENTS

2.6.1 Description

There are 24 gas vents installed in the landfill cover system. These gas vents are made of six-inch diameter solid ASTM A-53 Sch. 40 steel. They are tied into the geonet by a gravel pack that extends approximately five feet into the waste. A geomembrane boot is placed around the gas vent at the position that the vent protrudes the geomembrane.

2.6.2 Purpose

The purpose of the gas vents is to allow any potential landfill gases (e.g., methane, or similar compounds associated with the breakdown of organic matter) to escape the landfill subsurface, for the protection of the landfill cap, cover and seepage collection system.

2.6.3 Maintenance Requirements

The gas vents in the landfill will be inspected during quarterly inspections to detect signs of damage. If the vents are found to be damaged, they will be promptly repaired or replaced.

2.7 GROUNDWATER MONITORING SYSTEM

2.7.1 Description

The Edward Allen Landfill has a groundwater monitoring system that is comprised of both groundwater monitoring wells and piezometers. The groundwater monitoring wells are installed outside the limits of waste.

There are a total of five piezometers located on the Site. Four of these piezometers are located within the limits of the waste. The piezometers located within the limits of the waste are installed to monitor the long-term effects the cap system has on the elevation of the ground water table.

2.7.2 Purpose

The groundwater monitoring system serve to allow maintenance personnel to monitor the elevation of the groundwater table in and around the landfill, as well as to collect samples of groundwater to be analyzed for compliance and permitting.

2.7.3 Maintenance Requirements

Groundwater monitoring wells and piezometers will be annually inspected for signs of damage. If damage is observed, or routine sampling indicates a problem with one or more of the wells or piezometers, it may be necessary to re-develop or replace the wells or piezometers.

2.8 RECORDKEEPING AND REPORTING REQUIREMENTS

Maintenance and monitoring activities will be performed for a period of 30 years following closure unless reviews indicate that a different maintenance and monitoring period is warranted.

The recordkeeping requirements for the landfill consist of filling out the inspection checklist, provided in Table 2, during routine inspections. Copies of records, reports, or other information relative to maintenance and monitoring activities at the Edward Allen Landfill will be provided to the New York State Department of Environmental Conservation (NYSDEC) by the PRP Group.

3. Long-term Monitoring

3.1 INTRODUCTION

A long-term monitoring program is conducted at the Site to evaluate the effectiveness of the remedial action and to monitor discharges from the Site. The program includes monitoring the groundwater, surface water and air, as well as cap elevations. The landfill cap elevation will be monitored to assess long-term settlement of the cap system. The long-term monitoring program for ground water, is set up by identifying sample matrices, types, containers, preservation, holding times, disposal procedures and chain of custody for the sample collected.

The sample matrices consist of groundwater samples. The sample types consist of environmental samples with various types of quality control samples. The frequency of collection and purpose of the various quality control samples are described in the Site Data Collection Quality Assurance Plan (DCQAP) for the Operation and Maintenance Program (Appendix C). The sampling location and frequency for wells and surface water, as well as the analytical parameter and EPA method of analysis to be run for each sample, are include in Table 1.

The sample containers to be utilized in collecting the water samples will be consistent with the analytical methods specified and with the analytical laboratory's protocol. The sample containers are listed in Table 4 of the Site DCQAP.

Sample preservation procedures and holding times will be followed in accordance with the specification of the analytical methods and with the analytical laboratory protocol. Sample preservation holding times are presented in Table 4 of the Site DCQAP.

Chain of custody procedures will be instituted and followed throughout the investigation. These procedures are outlined in the Site DCQAP.

3.2 GROUNDWATER MONITORING

3.2.1 Sampling and Field Measurement Locations

The ground water monitoring locations for the Edward Allen Landfill include shallow, intermediate and deep ground water monitoring wells. The monitoring wells that will be monitored include well nests OBG-4, 7, 10, 11, 12, 13, 14 and 15. The location of these wells can be found on Z-1 of the Record Drawings. The Record Drawings for the Site are located in Volume 2 - Related Documents.

3.2.2 Sampling and Field Measurement Frequency

Ground water monitoring will be conducted annually.

3.2.3 Groundwater Sampling Procedures

To reduce the need to handle large volumes of purge water, Low Stress/Low Flow Methods are to be utilized. The following section provides a general overview of the sampling procedure. A detailed description is provided in the attached Standard Operating Procedure (SOP) for low flow sampling.

Prior to sample collection, groundwater elevation measurements shall be collected using a decontaminated electric probe. The volume of water in the well is to be calculated. A low-flow pump (oftentimes a bladder pump), safety cable, tubing, and electrical line is lowered slowly into the well so as the pump intake is at the midpoint of the well screen, preventing the disturbance and resuspension of any sediment in the screen base. Low-flow pumping rates are to cause less than 0.2 ft water level drawdown in the well.

Water level measurements should be collected every three to five minutes. While purging the well, measurements of water quality indicator parameters utilizing an in-line flow-through cell (or similar equipment) should be collected then as well. Sampling will be conducted once the parameters have stabilized (three successive readings are within acceptable tolerances).

The following protocol follows the flow chart presented in the NYSDEC Memorandum (TAGM) of September 30, 1988, from Mr. Michael J. O'Toole Jr. regarding the policy for alternation of groundwater samples collected for metals analysis. The following assumptions apply to the monitoring wells and to the TAGM flow chart: monitoring wells were properly designed, installed and developed, and have integrity.

The sample will be measured for turbidity in the field. Depending on the turbidity, one of the following two actions will be taken:

- *Turbidity Less Than 50 NTU*: If the turbidity of the sample is less than 50 nephelometric turbidity units (NTUs), it will be placed in a 500 ml polypropylene container (or equivalent), and the pH will be adjusted to 2 or less with reagent grade nitric acid. Samples will be stored pending transport to the analytical laboratory.
- *Turbidity Greater than or Equal to 50 NTU*: If the turbidity is greater than or equal to 50 NTU, the sample will be filtered in the field or at the laboratory. Filtration location is at the discretion of the field team, with NYSDEC approval. In addition, an unfiltered sample will also be collected, adjusted to pH of 2 or less with reagent grade nitric acid, and stored at the laboratory.

Purge water shall be collected and transferred directly into the nearest seepage collection manhole. Decontamination fluids should be segregated and collected separately from wash groundwater containers.

The following equipment will be required for the sample and elevation monitoring:

- Electric water level probe
- Bailer with polypropylene rope
- Bladder pump
- Bladder replacements (unique per well)
- Tubing (air and water lines, each unique per well)
- Key to wells
- Key to gates
- Turbidity meter
- In-line flow-through cell instrument
- Sampling containers
- Chain of custody forms
- Buckets

- Field logs
- Alconox detergent
- Methanol
- Distilled water
- Cooler with ice

3.3 GROUNDWATER MONITORING DATA EVALUATION

The groundwater analytical data shall be evaluated to:

- Identify analytes that are present at concentrations exceeding class GA standards;
- Evaluate potential trends in the data; and,
- Focus the long-term monitoring efforts on relevant chemicals and well locations.

A schematic of the data evaluation process is summarized below. The identified scheme will be applied on a chemical specific and well specific basis.

Post-Closure Baseline Conditions. In order to establish the post-remediation baseline conditions a baseline data set was collected and compiled. This data forms the basis to evaluate further monitoring needs, establish baseline conditions, and identify temporal trends in the observed concentrations.

Compare with GA standards. The maximum observed downgradient concentrations will be compared with the appropriate GA standard. If the maximum observed concentration is less than the GA standard, then that analyte/well shall not be included in future monitoring efforts.

Evaluate Trends. For analytes exceeding the GA standard, the data will be evaluated for decreasing or increasing temporal trends. If a statistically significant decreasing trend (95 % Confidence Level) is observed, then the most recent observation will be compared with the GA standard. Exceedance of the standard will trigger continued monitoring according to the monitoring schedule. If the most recent observation is less than the GA standard, then exclusion of that analyte/well from the monitoring program may be considered. If significant increasing trends (in excess of the GA standard) are observed for a given analyte and well, the analyte concentrations in that well will be compared to upgradient concentrations. If the observed downgradient concentrations are less than the upgradient concentrations, then monitoring will be continued for that constituent. If the downgradient concentrations exceed upgradient concentrations, then this will be noted in the monitoring report, and appropriate actions will be discussed with NYSDEC.

Compare with Background. For analytes showing no significant trends, the baseline concentrations in downgradient wells will be compared with the concentrations detected in upgradient wells. If the downgradient concentrations are less than or equal to the upgradient concentrations; then that analyte/well shall not be included in future monitoring efforts.

Establish Control Limits. For analytes showing stable baseline conditions, an appropriate control chart and upper control limits will be established. These control limits will be used to evaluate additional monitoring data as it develops.

Continue Monitoring. Long-term monitoring will be continued (as necessary) following evaluation of the baseline data. An initial evaluation of baseline data will be conducted based on the first three years

of monitoring data (i.e., 8 observations), at which time the baseline data will be evaluated. Additional data will be collected on a semi-annual basis, and the baseline data set will be updated to include the additional data. Following 5 years of monitoring (i.e., 12 observations), the decision cycle will be applied to a "moving window" of the most recent 12 observations.

Modifications to Monitoring. The sampling locations, frequency, and analytical parameters may not be changed or excluded without approval of the NYSDEC. Any requests to modify any part of the program from what is presented in this document will require that a written request be provided to the NYSDEC for review and approval.

Statistical Methods. The following reference materials were used in identifying the appropriate statistical techniques:

- U.S.EPA, 1989, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities*, Office of Solid Waste Management Division, U.S.EPA, Washington D.C.
- Gilbert, R.O., 1987, *Statistical Methods for Environmental Pollution Monitoring*, Van Nostrand Reinhold Company, Inc., New York, New York.

Statistical analyses will be conducted for each chemical of potential concern at individual wells at the Site.

Exploratory data analysis will be performed prior to implementing statistical techniques. The objective of the exploratory analysis will be to identify potential statistical distributions, correlations, and categorical associations. Based on the exploratory analysis, appropriate parametric and/or non-parametric statistical methods will be selected. Parametric methods refer to techniques that are based on known characteristics of the underlying statistical distribution of the parameter of interest (e.g., is it normal, log-normal, or other). An example of a widely used parametric technique is the two-sample T-test, which is based on the assumption that the underlying parameter is distributed as a normal distribution. Therefore, many parametric techniques may not be valid if the underlying distribution is not a normal[1], or if there is insufficient data to infer the underlying parameter distribution. Non-parametric methods may be applicable even if the shape of the underlying parameter distribution is not known. As such, non-parametric techniques will be preferred in situations where parametric methods are not suitable (i.e., when the underlying distribution is non-normal, or there is insufficient information to infer the underlying distribution). For most of the commonly utilized parametric techniques, analogous non-parametric have been developed. For example, the Wilcoxon rank sum procedure is the non-parametric equivalent of the two sample T-test. The Wilcoxon rank sum procedure is based on a statistical comparison of the average rank of the data in each of the two groups rather than a comparison of the arithmetic mean of the two groups. For comparison across multiple groups (rather than two groups), the Kruskall-Wallis rank sum test is the non-parametric equivalent of Analysis of Variance (ANOVA) (extension of the two sample T-test to evaluate multiple comparisons). Since the statistical analysis at this Site will be based on relatively few data points, there may be limited data from which to infer the underlying distribution of the parameters of interest. As such, non-parametric statistical techniques may be utilized rather than parametric analyses as appropriate.

[1] If the underlying distribution is not a normal distribution, but the distribution shape is known (e.g. log-normal), the data may be transformed so that the resultant distribution is normal.

A brief explanation of the methodology for the proposed tests is presented below. The proposed techniques are established statistical techniques which have widespread acceptance and are described in numerous textbooks. Details of specific calculations are presented in Appendix D, which was taken from Gilbert 1987 (*Statistical Methods for Environmental Pollution Monitoring, Van Nostrand Reinhold Company, New York*) and USEPA 1989 (*Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities,* EPA/530-SW-89-026).

A description of the statistical methods for the long-term monitoring program is presented below. The tests will be applied individually for each well and analyte. These method numbers (e.g., Method A) refer to the decision points related to the GA Standards. Prior to implementing the statistical procedures, the baseline data set will be evaluated for statistically significant seasonal variations in the observed concentrations. Seasonality will be evaluated by sorting the data for each well according to season. The observed concentrations for each season will be compared for statistically significant differences using the Wilcoxon rank sum test (as described in Method B below). If significant seasonal effects are observed, the statistical procedures described below will be adjusted to account for seasonality.

Method A. Evaluation of long-term trends. Time series charts will be maintained throughout the monitoring period and will be examined for visual signs of trends or deviations from control limits. The time series charts are an important component of the data analysis process since they may provide visual clues of trends in the data that may not be evident based on statistical testing alone. The Kendall test, a non-parametric test of association, as described in Gilbert 1987, will be utilized to evaluate potential long-term trends. Conceptually, the basis for the test is to order the data; from each well chronologically and evaluate if each observation is greater than or less than the preceding observation. An apparent trend is indicated if a certain number of consecutive observations are greater than or less than the immediately preceding observation. As described in Appendix D, the potential significance of the trend is evaluated by computing the Mann-Kendall test statistic (S), and its variance (VAR S). 1lhis information is used to calculate a Z statistic, which is compared with the critical value of Z at the 95 % CL (a = 0.05) from standard normal probability tables. If Z is greater than the critical value, there is sufficient evidence for a significant trend. If Z is less than the critical value, there is insufficient evidence for a long-term trend.

A Kendall trend analysis will be performed separately for each well.

Method B. Evaluate if the analyte concentrations in individual downgradient monitoring wells are significantly different from the concentration detected in upgradient wells. The Kruskall Wallis test will be used to evaluate if the analyte specific concentrations in individual wells are significantly different to upgradient wells. The Kruskall Wallis a multiple comparison version of the Wilcoxon rank sum test and is the non-parametric equivalent of ANOVA (parametric procedure). As shown on Appendix D, the Kruskall Wallis test, a compares the average ranks between multiple groups. A test statistic, known as the Kruskall Wallis statistic (K statistic) is computed. The K. statistic is analogous to the t statistic in a two-sample t-test. The K. statistic is distributed as a chi-square distribution (as compared with a t distribution for the t statistic). Therefore, if the K statistic exceeds the chi-squared critical value at the 95 % confidence level (i.e., a = 0.05), there is sufficient evidence to indicate that at least two of the groups being compared are different. If the K statistic is less than the critical chi-squared value, there is insufficient evidence to indicate that the groups are significantly different to each other (i.e., the downgradient concentrations are the same as the upgradient concentrations).

Method C. Establish control limits. Control charts are useful techniques for detecting shifts in the behavior of a system relative to baseline conditions. Control charts are useful graphical tools because they provide a basis for action, i.e., they indicate when changing data patterns over time should be examined to determine causes· for temporal fluctuations. As discussed by USEPA (1989) (Statistical Analysis of Ground Water Monitoring Data at RCRA Facilities) the information needed to construct a control chart is the number of observations, mean, range, and standard deviation. From historical information the control center line (the sample mean), and the upper and lower control limits are computed and plotted. The recorded result from subsequent sampling rounds are compared with the upper and lower control limits. If the detected concentration is outside the control limits, then the system is said to be "out of control", and further evaluation may be appropriate.

Control charts are only appropriate if the sequential data in a well are unrelated, i.e., there are no time related trends. As such, control charts will not be constructed for wells and analytes showing significant time related trends. Theoretically, control charts are only applicable for data which are normally distributed. However, since control charts are not constructed for the purpose of making precise probability statements, they are useful for identifying if the system is out of control, even if there is limited knowledge regarding the underlying distribution.

3.4 SURFACE WATER MONITORING

Surface water monitoring is no longer performed on the Site.

3.5 AIR MONITORING

3.5.1 Sampling and Field Measurement Locations

Air monitoring will be conducted to evaluate discharges from the landfill gas vents and from vents on the seepage collection and storage system.

3.5.2 Sampling and Field Measurement Frequency

Air monitoring sample collection will be conducted annually as part of the routine landfill inspections.

3.5.3 Sampling Procedures

Monitoring will be conducted utilizing a photoionization detector (PID), and a combustible gas monitor (CGM). Each will be calibrated per the manufacturers' instructions prior to sampling activities. Sampling will be conducted at the face of the vent opening.

3.6 HOMEOWNER WELL MONITORING PROGRAM

3.6.1 Description

Ground water samples from up to three homeowner wells are included in the long-term monitoring program. Ground water samples obtained from the residential wells will be collected from the exterior tap closest to the well head, prior to the ground water entering any on-line water treatment system. The tap will be turned on and the water will be allowed to flow until temperature, pH, and conductivity readings stabilize. Once the readings have stabilized, the tap will be shut back to a very low flow, and

the sample will be collected directly from the tap. The sample will be analyzed for the parameters indicated in Table 1.

3.6.2 Agreement with New York State Department of Health

The New York State Department of Health (NYSDOH) provided the initial notification to the homeowners of the monitoring program. The NYSDOH will also provide assistance with sample collection if access problems occur.

3.7 RECORDKEEPING AND REPORTING REQUIREMENTS

The long-term monitoring activities will be performed for a period of 30 years following closure. Modification of monitoring procedures will be made only with the concurrence of the NYSDEC. The results of ground water, and air monitoring will be summarized in annual reports. Copies of all records, reports, or other information related to monitoring activities at the landfill will be provided to the NYSDEC by the PRP Group.

4. Emergency Contingency Plan

4.1 INTRODUCTION

The emergency contingency plan presented in this section will be implemented in the event that a component of the Remedial Design fails to operate in accordance with the intent of the Remedial Design.

4.2 ODOR CONTROL

If during the inspections outlined in this Operation and Maintenance Plan, noxious odors are detected emanating from the gas vent, or from vents on the leachate collection and storage system, it may become necessary to implement remedial measures to control vapors from vents. This should be necessary only if the odors present a nuisance to local residences or to routine maintenance activities. Remedial measure implementation will be conducted with the concurrence of NYSDEC and NYSDOH.

4.3 HEAVY RAINS

Repeated heavy rainfall could cause erosion of the final cover. If this happens, the eroded area would be scarified, and additional cover material added, if necessary, and recompacted. Topsoil would then be applied and seeded. Areas of persistent erosion may require utilization of an erosion control fabric or ditching and rip-rap.

4.4 SEEPAGE

The low permeability cover, seep collection system, and surface water control will minimize seepage generation. If inspections identify the presence of seeps, the point at which the seep starts would be located and the seep eliminated. This may be accomplished by removing and reinstalling the cover as required to stop the flow of the seep. As an additional measure, the seep may be piped directly to the seep collection system. Erosion of the side slopes which may result from the seep would also be repaired by regrading, filling, and reseeding. If a seep is persistent, an investigation would be undertaken to determine the cause of the seep and an appropriate plan and schedule would be developed for permanently controlling the seep.

4.5 SEEPAGE QUANTITIES

In the event that quantities of seepage generated increase to the point where the seepage handling system is being overwhelmed, an evaluation should be performed to identify the source of the seepage quantities being collected.

4.6 SEEPAGE COLLECTION AND STORAGE SYSTEM

Precipitation of solids from the seepage could produce excessive solids build-up in the seepage collection system piping, valves, and storage tanks. If this occurs, cleaning of the pipes, valves, and/ or tanks will be necessary to maintain the flow capacities in the seep collection system.

The underground collection tanks are also fitted with a remote level alarm system to contact operations personnel using a cellular modem. The tank level alarm system will be programmed to communicate high liquid level indications at exceedance of the set point limits. A moisture sensing, interstitial leak detection system is installed. The leak detection system will communicate with the operations personnel in conjunction with the tank level alarm system. Collection of seepage will be scheduled based on rate of filling experience.

4.7 SURFACE WATER CONTROL CHANNEL

If flow in the surface water runoff control channel becomes inhibited by the displacement of rip-rap or the accumulation of excessive debris or soils from the erosion of the adjacent embankment, appropriate measures would be taken to repair or clean the channel to maintain flow capacities. Areas of persistent channel erosion may require additional improvements including regrading, filling or placement of rip-rap.

4.8 GROUNDWATER QUALITY

The impact of the closed landfill on ground water quality will be monitored by routine sampling and analysis of Site ground water monitoring wells. As discussed in Section 3.2, three homeowner wells in the vicinity of the Site will also be periodically sampled. The NYSDEC will be provided with the results of sampling and analyses.

4.9 HEALTH AND SAFETY

As concluded in the approved FS, implementation of the recommended alternative will be protective of human health and the environment. Therefore, no additional health and safety measures are required during the post-closure period as long as the remedial components continue to properly function. Health and safety measures to be implemented during the post closure period include restricting Site access, ground water monitoring, and gas vent monitoring. These measures are meant to both monitor the effectiveness of the remedial components and prevent human contact with Site-related contaminants.

In the event that routine maintenance and monitoring activities indicate problems with the remedial components, activities outlined in this contingency plan would be implemented. The type of health and safety requirements to be implemented in the event of failure of the remedial components would depend on the type of failure and field activities conducted in implementing this contingency plan. It is likely that health and safety requirements utilized in the event of implementation of this contingency plan will be similar to those implemented during remedial construction. However, it may be necessary to develop specific health and safety requirements and procedures to address the specific conditions encountered.

4.10 EMERGENCY CONTACTS

In the event of an emergency at the Site, Corning Incorporated and ViacomCBS, Inc. should be contacted as appropriate. The current addresses and phone numbers are as follows:

- Mr. John Novotny, P.E.
  Director – Global Environment & Sustainability/Capital Projects & Facilities/Energy Management
  Corning Incorporated
  HP ME 03-83
  Corning, NY 14831
  Phone: (607) 542-2472
- Mr. Chad Coy, P.E.
  Senior Project Manager
  Environmental Projects
  ViacomCBS, Inc.
  20 Stanwix Street, 10th Floor
  Pittsburgh, PA 15222
  Phone: (412) 642-4162

The NYSDEC and NYSDOH may also be contacted, as necessary. The current addresses and phone numbers are as follows:

- Ms. Danielle Miles
  Assistant Engineer - Division of Environmental Remediation
  NYSDEC – Region 8
  6274 East Avon-Lima Road
  Avon, New York 14414-9519
  Phone: (585)226-5349
- Ms. Angela Martin
  Public Health Specialist
  Bureau of Environmental Exposure Investigation
  Corning Tower, Rm. 1787
  Albany, NY 12237
  Phone: (518) 402-7860

TABLES

TABLE 1
SAMPLE LOCATIONS AND ANALYTICAL PARAMETER LIST
Edward Allen Landfill
Corning, New York

Sample Point	Position Relative to Landfill	Annual Monitoring Event (June – July)			
		Metals	VOCs	PID	CGM
MONITORING WELLS					
MW-4S	On property, down gradient base of the landfill cap	X			
MW-4D	On property, down gradient base of the landfill cap	X			
MW-7S	Off property cross/down gradient	X	X		
MW-7D	Off property cross/down gradient	X	X		
MW-10S	On property near seepage recovery tanks	X			
MW-10D	On property near seepage recovery tanks	X			
MW-11S	Off property, down gradient	X			
MW-11D	Off property, down gradient	X			
MW-12S	Off property, down gradient	X			
MW-12D	Off property, down gradient	X			
MW-13S	Off property, down gradient	X	X		
MW-13D	Off property, down gradient	X	X		
MW-14S	Off property, up gradient	X			
MW-14D	Off property, up gradient	X			
MW-15S	Off property, up gradient	X			
MW-15I	Off property, up gradient	X			
MW-15D	Off property, up gradient	X			
RESIDENTIAL WELLS					
Allen	Off property, down gradient	X			
Horrigan/Subroto	Off property, down gradient	X			
Coburn/Williams (formerly)Rarrick	Off property, down gradient	X			
LANDFILL GAS VENT AIR MONITORING					
LGV 1-24	On Property			X	X

Metals = TAL metals analyzed by EPA Methods 6010B and 7470A
VOCs = volatile organic compounds analyzed by EPA Method 8260B

TABLE 2
QUARTERLY INSPECTION PROCEDURES
EDWARD ALLEN LANDFILL

1. LOW PERMEABILITY COVER
Observe the condition of the cap, including vegetative cover, evidence of erosion or animal holes.
2. SEEPAGE COLLECTION SYSTEM
Seepage Collection Trenches Visually inspect manhole, describe functionality, any build-up of solids, and flow conditions.
Seepage Collection Vaults Observe the presence of water in the vaults (pump out if needed). Observe functionality of valves, piping, and instrumentation.
Underground Storage Tank System Observe the condition of tanks, including functionality of the tank and all instrumentation (level and secondary containment sensors). Confirm reading by gauging the tank with a stick (located at the control building)
Seepage Disposal Confirm seepage logs are present and complete, Confirm loads and location of disposal.
3. CONTROL SYSTEM
Observe the operation of the control and monitoring system. Ensure all sensors are reading properly.
4. SITE SECURITY
Observe the perimeter fence in all locations. Ensure that the site is secure, and all that access gates are locked.
5. SITE DRAINAGE
Observe the stormwater drainage ditch and drainage area. Ensure that the ditch is clean and clear obstruction. Ensure that the water leaving the site is flowing freely and is clear.
6. ACCESS ROAD
Observe all access roads to the site. Ensure that all roads are clear of obstructions and vegetation and in good condition.
7. GROUND WATER MONITORING WELLS
Observe all on-site and off-site monitoring wells. Ensure that all monitoring wells are in good condition.
8. LANDFILL GAS VENTS
Observe all landfill gas vents (LGV's). Ensure that all LGV's are in good condition.

TABLE 2 (continued)
EDWARD ALLEN LANDFILL
SEEPAGE MANHOLE INSPECTIONS

Inspector(s):_____ Date:_____

Manhole #	Observation
MH-1	
MH-2	
MH-3	
MH-4	
MH-5	
MH-6	
MH-7	
MH-8	
MH-9	
MH-10	
MH-11	
MH-12	
MH-13	

Weather conditions during inspection: _____

Weather conditions during previous 24-hours: _____

Visual monitoring is performed by observing the presence or absence of liquid/flow within the pipes (channel) at each of the manhole locations. If liquid/flow is observed documentation the following descriptions are used: moist (wet but no flow); trace flow (i.e. a trickle of moving water); moderate flow (less than 1 inch), significant flow (more than 1 inch). Color, clarity and presence of solids in the flow will be described, if flow is present.

APPENDIX A

Site Health and Safety Plan

Safety
in everything we do

HALEY ALDRICH HCS ect2

HALEY & ALDRICH, INC.

SITE-SPECIFIC SAFETY PLAN

FOR

CORNING - EDWARD ALLEN LANDFILL
Project/File No. 0129773

Prepared By: McKenna, Santa	**Date:** 02-14-2018

EMERGENCY INFORMATION

Project Name : Corning - Edward Allen Landfill	**H&A File No :** **0129773**
Location : **Bailey Creek Road Corning, New York**	
Client/Site Contact: Phone Number:	Corning Incorporated John Novotny 607.542.2472
H&A Project Manager: Phone Number:	Janice Szucs 585.321.4211
Regional Health & Safety Manager: Emergency Phone Number:	Andrew Foerster 216.706.1318
Nearest Hospital: Address: (see map on next page) Phone Number:	**Guthrie Corning Hospital** 1 Guthrie Drive Corning, NY 14830 607-937-7200
Nearest Occ. Health Clinic: Address: (see map on next page) Phone Number	**Five Star Urgent Care - Big Flats** 830 County Rd 64 Elmira, NY 14903 607-846-2030
Liberty Mutual Claim Policy	**WC7-Z11-254100-038**
Other Local Emergency Response Number:	911
Other Ambulance, Fire, Police, or Environmental Emergency Resources:	911

Emergency Hospital

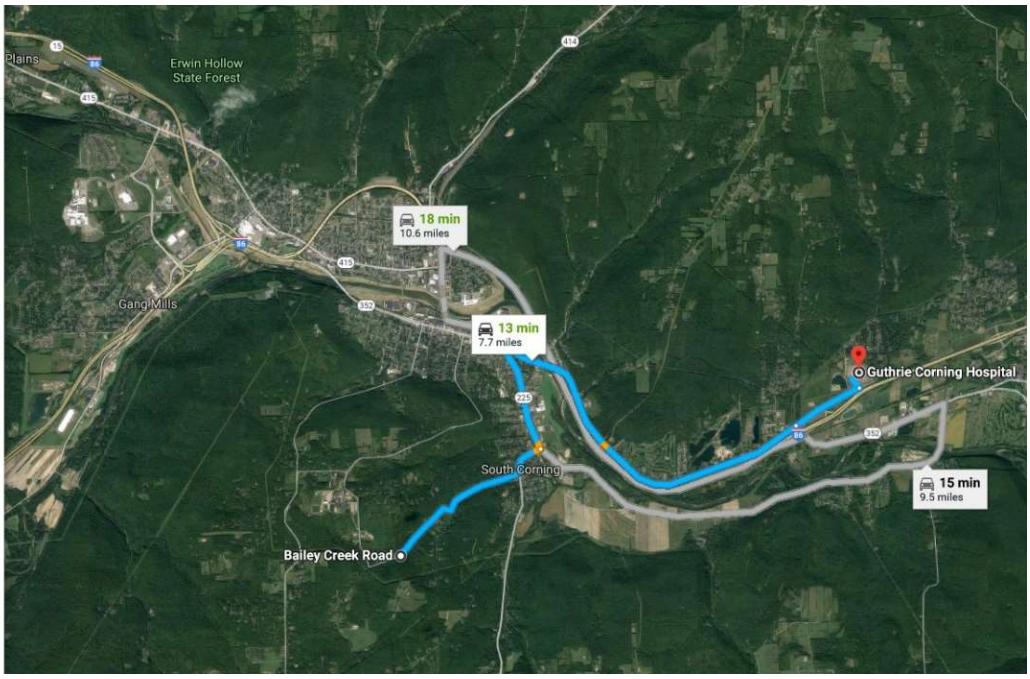
Guthrie Corning Hospital
1 Guthrie Drive Corning, NY 14830
607-937-7200

13 min (7.7 miles)
via E Corning Rd
Fastest route, the usual traffic

Bailey Creek Rd
Corning, NY 14830

- Head northeast on Bailey Creek Rd toward Ellison Rd
  1.6 mi
- Turn left onto Caton Rd
  0.4 mi
- Turn left onto Park Ave
  1.1 mi
- Park Ave turns slightly right and becomes Conhocton St
  203 ft
- Turn right onto NY-352 E/E Corning Rd/Denison Pkwy E
  Continue to follow NY-352 E/E Corning Rd
  3.8 mi
- Continue straight onto E Corning Rd
  0.8 mi
- Turn left onto Guthrie Dr
  0.1 mi

Guthrie Corning Hospital
1 Guthrie Drive, Corning, NY 14830



Clinic

Five Star Urgent Care - Big Flats
830 County Rd 64 Elmira, NY 14903
607-846-2030

18 min (11.0 miles)
via River Rd
Fastest route

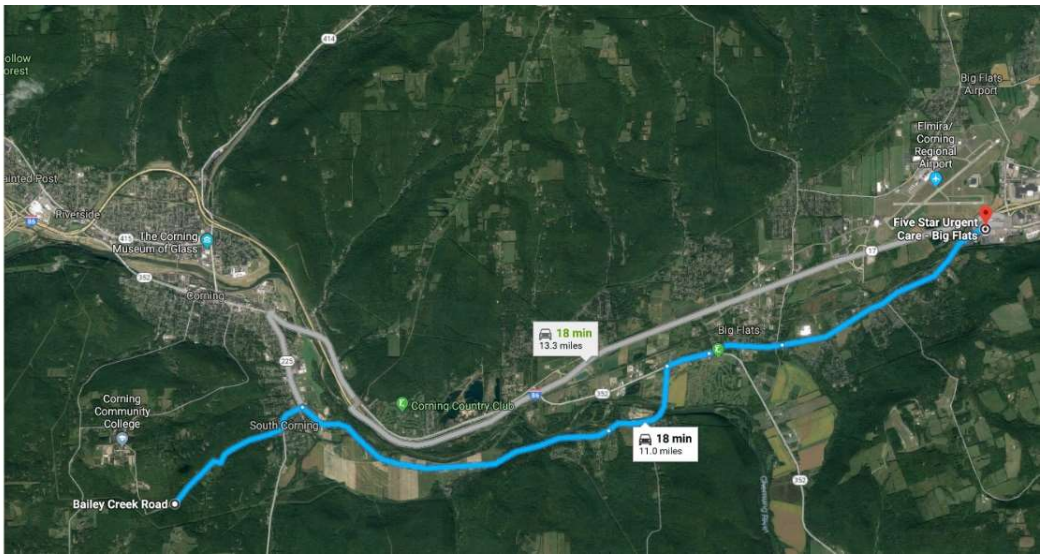
Bailey Creek Rd
Corning, NY 14830

Drive from Bailey Creek Rd, River Rd and Big Flats Rd to Big Flats Airport
17 min (10.9 mi)

Drive to your destination
32 s (390 ft)

Five Star Urgent Care - Big Flats
830 County Rd 64, Elmira, NY 14903

These directions are for planning purposes only. You may find that construction projects, traffic, weather, or other events may cause conditions to differ from the map results, and you should plan your route accordingly. You must obey all signs or notices regarding your route.



STOP WORK

In accordance with H&A Stop Work Policy (OP1035), any individual has the right to refuse to do work that they believe to be unsafe and they have the obligation and responsibility to stop others from working in an unsafe manner without fear of retaliation. STOP Work Policy is the stop work policy for all personnel and subcontractors on the Site. When work has been stopped due to an unsafe condition, H&A site management (e.g., Project Manager, Site Safety Manager) and the H&A Senior Project Manager will be notified immediately. Reasons for issuing a stop work order include, but are not limited to:

- **The belief/perception that injury to personnel or accident causing significant damage to property or equipment is imminent.**
- **A H&A subcontractor is in breach of site safety requirements and / or their own site HASP.**
- **Identifying a sub-standard condition (e.g., severe weather) or activity that creates an unacceptable safety risk as determined by a qualified person.**

Work will not resume until the unsafe act has been stopped OR sufficient safety precautions have been taken to remove or mitigate the risk to an acceptable degree. Stop work orders will be documented as part of an on-site stop work log, on daily field reports to include the activity(ies) stopped, the duration, person stopping work, person in-charge of stopped activity(ies), and the corrective action agreed to and/or taken. Once work has been stopped, only the H&A SM or SSO can give the order to resume work. H&A senior management is committed to support anyone who exercises his or her "Stop Work" authority.

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ADMINISTRATIVE INFORMATION

Project Name	Corning - Edward Allen Landfill	**Project Number**	0129773
Project Start Date	02-19-2018	**Project End Date**	TBD
Client Site/Contact: Phone:	**John Novotny** 607.542.2472		
H&A Project Manager: Phone:	**Janice Szucs** 585.321.4211		
H&A Site Safety Officer Phone:	**Gonzalez, Samantha** 585.321.4224		

APPROVALS: The following signatures constitute approval of this Health & Safety Plan

Electronic Signature

Site Project Manager — 02/23/18 Date

Corporate H&S — 02/20/18 Date

This document is valid for a maximum time period of one year after completion. The document must be reviewed if the scope of work or nature of site hazards changes and must be updated as warranted.

PROJECT INFORMATION

Site Overview/History

The Edward Allen Landfill (EAL) is a former landfill located on Bailey Creek Road in the Town of Corning, New York. The EAL was closed based on New York State Department of Environmental Conservation (NYSDEC) requirements and is currently subject to post closure monitoring, maintenance and annual reporting. Final closure of the EAL was completed in 1995 and routine operations, monitoring and maintenance activities have been performed since that time in accordance with the approved September 1995 Operations and Maintenance (O&M) Manual, as amended and/or supplemented (the O&M Manual) for the site.

Site Classification	Former Landfill	**Site Status**	Inactive	**Regulatory Authority**	HAZWOPER

Project Summary

Haley & Aldrich will conduct annual environmental monitoring requirements which consists of quarterly visual inspection of landfill gas vents and perimeter water collection manholes, annual landfill gas vents air monitoring, recording monthly seepage collection system and disposal volumes, and annual water sampling at selected groundwater monitoring wells on the EAL property and at nearby residential properties, and annual inspections of the site cover system and perimeter fencing.

Project Tasks

Task 1	Task Name**: Water Sampling**	
Annual water sampling at selected groundwater monitoring wells on the EAL property and at nearby residential properties		
Start Date : 03-05-2018	End Date :	
H&A Site Supervisor: Szucs, Janice		Subcontractor: None
Task 2	Task Name**: Site Walk**	
Quarterly visual inspection of landfill gas vents LGV and perimeter water collection manholes.		
Start Date : 03-05-2018	End Date :	
H&A Site Supervisor: Szucs, Janice		Subcontractor: None
Task 3	Task Name**: Site Walk**	
Conduct annual landfill gas vents air monitoring		
Start Date : 03-05-2018	End Date :	
H&A Site Supervisor: Szucs, Janice		Subcontractor: None
Task 4	Task Name**: Soil Sampling**	
Record monthly leachate seepage collection system and disposal volumes		
Start Date : 03-05-2018	End Date :	
H&A Site Supervisor: Szucs, Janice		Subcontractor: None

HAZARD ASSESSMENT AND CONTROLS

The following site and task specific hazards have been identified. Associated controls have been defined and are also listed below.

Site Chemical Hazards

Source of Information : Previous investigation,

COC	Location/Media	Concentration	Units
Trichloroethylene	**Groundwater**	**12**	**ug/L**
Manganese	**Groundwater**	**1.928**	**ug/L**
Barium	**Groundwater**	**3.882**	**ug/L**
Methane	**Air (breathing space)**	**ND to TBD**	**ppm**
Arsenic	**Groundwater**	**0.02668**	**ug/L**

Trichloroethylene

General Information - Trichloroethylene is a nonflammable colorless liquid with a sweet odor. Trichloroethylene vapor is heavier than air and is found in low lying areas.

Toxicity - Acute (short-term) exposure to Trichloroethylene may cause irritation to the eyes and the skin. If this liquid is swallowed, it may result in fluid entering the lower respiratory system and cause inflammation of the lungs. The substance may cause effects on the central nervous system, resulting in respiratory failure. Exposure could cause lowering of consciousness. Repeated or prolonged contact with skin may cause chronic dryness and irritation. The substance may have effects on the central nervous system, resulting in loss of memory. The substance may have effects on the liver and kidneys if individual is a regular drinker. This substance is probably carcinogenic to humans.

Flammability - Trichloroethylene is nonflammable.

Reactivity - On contact with hot surfaces or flames Trichloroethylene decomposes forming toxic and corrosive fumes (**phosgene**, hydrogen chloride). The substance decomposes on contact with strong alkali producing dichloroacetylene, which increases fire hazard. It reacts violently with metal powders such as magnesium, aluminum, titanium, and barium. It is slowly decomposed by light in presence of moisture, with formation of corrosive hydrochloric acid.

First Aid Procedures
Eye: Immediately wash (irrigate) the eyes with large amounts of water for 20 minutes, occasionally lifting the lower and upper lids. Further medical care is required.
Skin: Remove contaminated clothing and promptly flush the contaminated skin with water for 20 minutes.
Inhalation: Move the exposed person to fresh air at once. Artificial respiration may be required.
Ingestion: Rinse the individual´s mouth. Do not induce vomiting. Seek medical attention immediately.
Air Monitoring - Vapor monitoring is required to determine Trichloroethylene concentrations.

Monitoring can be specific for Trichloroethylene using integrated sampling or with a direct reading vapor monitor.

Occupational Exposure Limit(s)	
8 Hour TWA - 25 ppm	**STEL** - 100 ppm
Ceiling - 300 ppm	**IDLH** - 1000 ppm

Manganese

General Information -
Manganese is a silvery-gray metal that resembles iron. It is hard and very brittle, difficult to fuse, but easy to oxidize. It is not found as a free element in nature; it is often found in minerals in combination with iron. Manganese is a metal with important industrial metal alloy uses, particularly in stainless steels.

Toxicity -
Manganism is a condition that occurs when someone has been exposed to toxic levels of manganese. Symptoms tend to mimic Parkinson´s Disease and include gait disturbances, clumsiness, tremors, speech disturbances, and psychological disturbances. Metal fume fever is a temporary condition caused by inhaling manganese fumes. Symptoms typically include chills, fever, upset stomach, vomiting, dryness of the throat, cough, weakness, and achiness.

Flammability -
Combustible.

Reactivity -
Oxidizer - will react with water or steam to produce hydrogen.

First Aid Procedures
Eye :
No recommendation.

Skin :
No recommendation.

Inhalation :
If a person breathes large amounts of this chemical, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

Ingestion :
If this chemical has been swallowed, get medical attention immediately.

Air Monitoring -
Mixed Cellulose Ester Filter (MCEF) 0.8 microns, using Atomic Absorption Spectroscopy (AAS) by OSHA Analytical Method OSHA ID-121.

Occupational Exposure Limit(s)	
8 Hour TWA - 1 mg/m3	**STEL** - 3 mg/m3

Ceiling - 5 mg/m3	**IDLH** - 500 mg/m3

Barium

General Information - Barium can be found as a yellow to white lustrous solid. Because of its high chemical reactivity barium is never found in nature as a free element. The most common naturally occurring minerals of barium are barite (barium sulfate, $BaSO_4$) and witherite (barium carbonate, $BaCO_3$), both being insoluble in water. Barium has only a few industrial applications. The metal has been historically used as a getter for vacuum tubes. It is a component of high-temperature superconductors and electroceramics and is added to steel and cast iron to reduce the size of carbon grains within the microstructure of the metal. Barium compounds are added to fireworks to impart a green color. Barium sulfate is used as an insoluble heavy additive to oil well drilling fluid, as well as in a purer form, as X-ray radiocontrast agents for imaging the human gastrointestinal tract. Soluble barium compounds are poisonous due to release of the soluble barium ion, and therefore have been used as rodenticides.

Toxicity - Acute (short-term) exposure to Barium has been associated with eye, skin, and respiratory irritation.

Flammability - Barium is not flammable.

Reactivity - Pure barium may spontaneously ignite on contact with air if in powder form. The substance is a strong reducing agent and reacts violently with oxidizers and acids. Barium reacts violently with halogenated solvents. It reacts with water, forming flammable/explosive Hydrogen gas.

First Aid Procedures
Eye: Immediately wash (irrigate) the eyes with large amounts of water, occasionally lifting the lower and upper lids. Get medical attention immediately.
Skin: Promptly flush the contaminated skin with water. If this chemical penetrates the clothing, promptly remove the clothing and flush the skin with water. If irritation persists after washing, get medical attention.
Inhalation: move the exposed person to fresh air at once. Other measures are usually unnecessary.
Ingestion: In the event of ingestion rinse exposed individual´s mouth. Induce vomiting (ONLY IN CONSCIOUS PERSONS!). Seek medical attention immediately.

Air Monitoring - Particulate monitoring is required to determine barium concentrations. Monitoring can be specific for barium using integrated sampling or with a direct reading aerosol monitor. When monitoring with the direct reading instrument, dust equivalent action levels must be calculated prior to sampling.

Occupational Exposure Limit(s)

8 Hour TWA - 0.01 mg/m3	**IDLH** - 5 mg/m3

Methane

General Information - Methane is a colorless odorless gas. It is also known as marsh gas or methyl hydride. It is easily ignited. The vapors are lighter than air. Under prolonged exposure to fire or intense heat the containers may rupture violently and rocket. It is used in making other chemicals and as a constituent of the fuel, natural gas.

Toxicity - The substance can be absorbed into the body by inhalation, skin and/or eye contact. Symptoms of overexposure to methane include cough, dyspnea (breathing difficulty), black sputum, decreased pulmonary

function, lung fibrosis, drowsiness and unconsciousness. Methane is a simple asphyxiant, which acts to displace oxygen in the environment.

Flammability - Methane is a flammable gas. When involved in a fire, this gas will ignite and produce toxic gases including carbon monoxide and carbon dioxide. An extreme explosion hazard exists in areas in which the gas has been released, but the material has not yet ignited.

Reactivity - Methane reacts violently with oxidizing agents (such as perchlorates, peroxides, permanganates, chlorates, nitrates, chlorine, bromine, and fluorine). Methane can react violently with boiling water and cold water. Liquefied Methane combined with liquefied oxygen can form an explosive mixture.

First Aid Procedures

Eye : Remove the person from exposure and flush eyes with large amounts of water for at least 15 minutes and seek medical attention.

Skin : Skin contact with liquid Methane can cause frostbite. Immerse affected part in warm water and seek medical attention.

Inhalation : Very high levels of Methane can decrease the amount of oxygen in the air and cause suffocation with symptoms of headache, dizziness, weakness, nausea, vomiting, loss of coordination and judgement, increased breathing rate and loss of consciousness. Remove the person from exposure and seek medical attention.

Ingestion : NA

Air Monitoring - A flame ionization detector (FID) shall be used to monitor methane and if over 1,000 ppm methane is measured, stop work will be initiated and 5 minutes will pass before being measured again. Oxygen levels should be maintained above 19.5%.

Occupational Exposure Limit(s)

8 Hour TWA - 1,000 ppm	-
-	**IDLH** - 5,000 ppm

Arsenic

General Information - Arsenic occurs in many minerals, usually in conjunction with sulfur and metals, and also as a pure elemental crystal. Arsenic is a metalloid. The main use of metallic arsenic is for strengthening alloys of copper and especially lead (for example, in car batteries). Arsenic is a common dopant in semiconductor electronic devices. Arsenic and its compounds, especially the trioxide, are used in the production of pesticides, treated wood products, herbicides, and insecticides.

Toxicity - Acute (short-term) exposure to Arsenic is irritating to the eyes, the skin and the respiratory tract. The substance may cause severe flu-like symptoms, loss of fluids and electrolytes, cardiac disorders, shock, convulsions and kidney impairment. Prolonged (chronic) contact with skin may cause severe irritation. The substance may result in pigmentation disorders, thickening of the outer skin, perforation of nasal septum, nerve impairment, liver impairment, and low red-blood cell counts. This substance is carcinogenic to humans and is regulated by OSHA as a carcinogen.

Flammability - Arsenic is not flammable. Antimony will evaporate when heated forming toxic fumes.

Reactivity - Arsenic reacts violently with strong oxidizers and halogens. When Arsenic contacts an acid the reaction forms Arsine, a highly toxic gas.

First Aid Procedures

Eye: Immediately wash (irrigate) the eyes with large amounts of water, occasionally lifting the lower and upper lids. Get medical attention immediately.

Skin: Promptly flush the contaminated skin with water. If this chemical penetrates the clothing, promptly remove the clothing and flush the skin with water. If irritation persists after washing, get medical attention.

Inhalation: move the exposed person to fresh air at once. Other measures are usually unnecessary.

Ingestion: In the event of ingestion rinse exposed individual´s mouth. Induce vomiting (ONLY IN CONSCIOUS PERSONS!). Seek medical attention immediately.

Air Monitoring - Particulate monitoring is required to determine arsenic concentrations. Monitoring can be specific for arsenic using integrated sampling or with a direct reading aerosol monitor. When monitoring with the direct reading instrument, dust equivalent action levels must be calculated prior to sampling.

Occupational Exposure Limit(s)

8 Hour TWA - 0.01 mg/m3	**IDLH** - 5 mg/m3

Site Hazards and Controls

Site Hazard Summary		
Sun	High Winds	Lightning Storms
Cold Temperatures (Cold Stress)	Hot Temperatures (Heat Stress)	Ticks
Mosquitoes	Stinging Insects	Remote
Small Mammals	Poisonous Plants	Slips and Trips
Poisonous Snakes	Animal Droppings	

SUN

Hazard Information

Acute excessive exposure to solar radiation may cause painful sunburn, and chronic exposure may contribute to eye damage and skin cancer. The average peak intensity of solar ultraviolet (UV) radiation is at midday. Most of the total daily UV is received between 10 AM and 2 PM. UV radiation can reflect off of water, concrete, light colored surfaces, and snow. Cloud cover can reduce UV levels, but overexposure may still occur.
Use the shadow test to determine sun strength: If your shadow is shorter than you are, the sun´s rays are at their peak, and it is important to protect yourself.

Controls

- Wear light-colored, closely woven clothing, which covers as much of the body as practicable.
- Use sunscreens with broad spectrum protection (against both UVA and UVB rays) and sun protection factor (SPF) values of 30 or higher. Ideally, about 1 ounce of sunscreen (about a shot glass or palmful) should be used to cover the arms, legs, neck, and face of the average adult. Sunscreen needs to be reapplied at least every 2 hours to maintain protection.
- Hats should be worn and should be wide brimmed, protecting as much of the face, ears, and neck as possible. Hats should also provide ventilation around the head. Sunscreen should be applied to areas around the head not protected by the hat (ears, lips, neck, etc.).
- Wear sunglasses while working outdoors. Sunglasses should allow no more than 5% of UVA and UVB penetration and should also meet the ANSI Z87.1 standard for safety glasses.
- Use natural or artificial shade, where possible.

HIGH WINDS

Hazard Information

While high winds are commonly associated with severe thunderstorms and hurricanes, they may also occur as a result of differences in air pressures (e.g., when a cold front passes across the area).
High winds can cause downed trees and power lines and flying debris (e.g., dust and/or larger debris), which may make normal operations more hazardous or lead to power outages, transportation disruptions, damage to buildings and vehicles, and serious injury.
The following terms are used to describe wind conditions.
Wind Advisory: Sustained winds 25 to 39 mph and/or gusts to 57 mph. Issuance is normally site-specific. However, winds of this magnitude occurring over an area that frequently experiences such wind speeds will not trigger a wind advisory.

High Wind Warning: Issued by the National Weather Service when high wind speeds may pose a hazard or is life threatening.
Strong winds can make driving difficult, especially when driving high profile vehicles and across bridges and overpasses.

Controls

- Staff should monitor the weather and take measures to ensure objects are secure and personal safety is maintained.
- Operations that are unsafe in high winds should be discontinued until the wind velocity decreases and is acceptable for work to resume.
- Staff members should seek safe shelter until the wind has calmed down.
- When driving in high winds, maintain a firm grip on the wheel and keep a safe distance between vehicles. Pull over to a safe area if driving conditions are hazardous or deteriorate to the point where the driver is uncomfortable.

LIGHTNING STORMS

Hazard Information

Where the threat of electrical storms and the hazard of lightning are present, staff shall ensure site procedures exist to include the following:

- Detect when lightning is in the near vicinity and when there is a potential for lightning
- Notify appropriate site personnel of these conditions
- Implement protocols to stop work and seek shelter

The basis for an effective site-specific lightning warning system involves the following considerations:

- Time required to cease work or to make operations safe
- Time required to communicate pertinent information
- Time required to safely shelter personnel
- Movement speed of thunderstorms
- Distance between successive cloud-to-ground flashes
- Accuracy of lightning detection system
- Application of the "30-30 Rule"

30-30 Rule
If the time between seeing lightning and hearing thunder is less than 30 seconds, you are in danger of lightning strike.

  - Seek shelter immediately.
  - Stay indoors for more than 30 minutes after hearing the last clap of thunder.

Staff members should consult OP 1054 Electrical Storms & Lightning Protection for additional information regarding lightning storms.

Controls

- Identify and communicate the lightning response plan to be used at the project site. This plan should include staff responsibilities, storm detection methods, time required to cease work, shelter locations, and the process to resume work.
- **When thunderstorms threaten, do not start anything you can´t quickly stop.**
- Monitor the daily weather forecast and communicate it at the daily safety tailgate meeting. If the threat of a storm is in the forecast, the weather will be monitored throughout the workday with appropriate equipment or notification systems.
- Identify shelter locations. Vehicles (not including heavy equipment) can provide immediate protection if you are caught outside when lightning strikes, but should not be the primary safe refuge location. A permanent structure is a better option, if available.
- If you are in or near the water, head toward land immediately and find shelter. Take extra precautions when on the water and in a boat due to the additional dangers of high winds and waves.
- If there is no shelter, find a low-lying, open place that is a safe distance from trees, poles, or metal objects that are high electricity conductors. Make sure it is not likely to flood. Assume a tucked position: Squat low to the ground. Place your hands on your knees with your head tucked between them. Try to touch as little of your body to the ground as possible. Stay aware of your surroundings and the progress of the storm.

COLD TEMPERATURES

Hazard Information

Cold stress may occur at any time work is being performed during low ambient temperatures and high velocity winds. Because cold stress is common and potentially serious illnesses are associated with outdoor work during cold seasons, regular monitoring and other preventative measures are vital.

Staff members should consult OP1003-Cold Stress for additional information on cold weather hazards.

Cold Stress Conditions

Frostbite: Localized injury resulting from cold is included in the generic term "frostbite. There are several degrees of damage.

Symptoms: Frost nip or incident frostbite; sudden blanching or whitening of the skin.

- Superficial frostbite: Skin has a waxy or white appearance and is firm to the touch, but tissue beneath is resilient.
- Deep frostbite: Tissues are cold, pale, and solid; extremely serious injury.

Treatment:

- Bring the victim indoors and heat the areas quickly in water between 102° and 105° F.
    - Never place frostbitten tissue in hot water as the area will have a reduced heat awareness and such treatment could result in burns.
- Give the victim a warm drink (not coffee, tea, or alcohol).
    - The victim should not smoke or do anything that will inhibit blood circulation.

- Keep the frozen parts in warm water or covered with warm clothes for 30 minutes even though the tissue will be very painful as it thaws.
    - Elevate the injured area and protect it from injury.
    - Do not allow blisters to be broken. Use sterile, soft, dry material to cover the injured areas.
- Keep victim warm and get medical care immediately following first aid treatment.
- After thawing, the victim should try to move the injured areas slightly, but no more than can be done without assistance.

Do <u>NOT</u>:

- Rub the frostbitten area(s)
- Use ice, snow, gasoline, or anything cold on frostbite
- Use heat lamps or hot water bottles to rewarm the frostbitten area
- Place the frostbitten area near a hot stove

<u>Hypothermia:</u> Significant loss of body heat that is also a potential hazard during cold weather operations. Hypothermia is characterized as "moderate" or "severe".
Symptoms:

- Early hypothermia - Chills, pale skin, cold skin, muscle rigidity, depressed heart rate, and disorientation
- Moderate hypothermia - Any combination of severe shivering, abnormal behavior, slowing of movements, stumbling, weakness, repeated falling, inability to walk, collapse, stupor, or unconsciousness
- Severe hypothermia - Extreme skin coldness, loss of consciousness, faint pulse, and shallow, infrequent or apparently absent respiration

Death is the ultimate result of untreated hypothermia. The onset of severe shivering signals danger to personnel; exposure to cold shall be immediately terminated for any severely shivering worker.
Treatment: Staff members should seek emergency medical treatment in the event of hypothermia. The following actions can be taken prior to obtaining medical treatment:

- Gently place patients in an environment most favorable to reducing further heat loss from evaporation, radiation, conduction, or convection.
- Remove wet clothing and replace it with dry blankets or sleeping bags.
- Initiate active external rewarming with heat packs (e.g., hot water bottles, chemical packs, etc.) placed in the areas of the armpits, groin, and abdomen.
- Be aware of the risk of causing body surface burns from excessive active external rewarming.

In dire circumstances, rescuers may provide skin-to-skin contact with patients when heat packs are unavailable and such therapy would not delay evacuation.

Controls

- Recognize the environmental and workplace conditions that may be dangerous.
    - When the temperature is below 41° F, workers should be aware that cold stress is a potential hazard.
- Learn signs of cold-induced illnesses and injuries and how to help affected staff members.
    - Observe fellow staff members for signs of cold stress and administer first aid, where necessary.

- Staff members should maintain a clothing level that keeps them warm but dry (not sweating).
    - Staff should wear thermal clothing including gloves and footwear and beneath chemical resistant clothing, when appropriate.
    - Workers should have a spare set of clothing in case work clothes are not warm enough or become wet.
    - If a worker begins to sweat, he/she should remove a layer.
    - If clothing becomes wet and temperatures are below 36° F, clothing must be immediately replaced with dry clothing.
- A warm area for rest breaks should be designated.
    - In cold temperatures, rotate shifts of workers with potential cold stress exposure or take periodic breaks to allow recovery from cold stress.
    - Do not go into the field alone when cold stress could occur.
- Avoid fatigue or exhaustion because energy is needed to keep muscles warm.
- Workers should drink warm liquids (non-alcoholic, non-caffeinated) periodically throughout their shifts so they do not get dehydrated.

HOT TEMPERATURES (HEAT STRESS)

Hazard Information

Heat stress may occur at any time work is being performed at elevated ambient temperatures. Heat stress is one of the most common and potentially serious illnesses associated with outdoor work during hot seasons; therefore, regular monitoring and other preventative measures are vital. Site workers must learn to recognize and treat various forms of heat stress.
H&A employees and their subcontractors should be aware of potential health effects and/or physical hazards of working when there are hot temperatures or a high heat index.
Staff members should consult OP 1015 Heat Stress for additional information regarding hot weather hazards.

Heat Stress Conditions

Heat Rash: Caused by continuous exposure to heat and humid air and aggravated by chafing clothes. Decreases ability to tolerate heat.
Symptoms: Mild red rash, especially in areas of the body on contract with protective gear.
Treatment: Decrease amount of time in protective gear and provide powder to help absorb moisture and decrease chaffing.

Heat Cramps: Caused by perspiration that is not balanced by adequate fluid intake. Heat cramps are often the first sign of a condition that can lead to heat stroke. This condition is much less dangerous than heat stroke, but it nonetheless must be treated.
Symptoms: Acute painful spasms of voluntary muscles (e.g., abdomen and extremities).
Treatment: Remove the victim to a cool area and loosen clothing. Have the patient drink 1 to 2 cups water immediately, and every 20 minutes thereafter until symptoms subside. Total water consumption should be 1 to 2 gallons per day.

Heat Exhaustion: A state of definite weakness or exhaustion caused by the loss of fluids from the body.
Symptoms: Pale, clammy, moist skin, profuse perspiration and extreme weakness. Body temperature is normal, pulse is weak and rapid, and breathing is shallow. The person may have a headache, may vomit, and may be dizzy.
Treatment: Remove the person to a cool place, loosen clothing, and place in a head-low position. Provide bed rest. Consult physician, especially in severe cases. The normal thirst mechanism is not sensitive enough to ensure body fluid replacement. Have patient drink 1 to 2 cups water immediately

and every 20 minutes thereafter until symptoms subside. Total water consumption should be 1 to 2 gallons per day.

Heat Stroke: An acute and dangerous reaction to heat exposure caused by failure of heat regulating mechanisms of the body; the individual´s temperature control system that causes sweating stops working correctly. Body temperature rises so high that brain damage and death will result if the person is not cooled quickly.

Symptoms: Red, hot, dry skin, although person may have been sweating earlier; nausea; dizziness; confusion; extremely high body temperature; rapid respiratory and pulse rate; unconsciousness or coma.

Treatment: Cool the victim quickly and obtain immediate medical assistance. If the body temperature is not brought down fast, permanent brain damage or death may result. Soak the victim in cool but not cold water, sponge the body with rubbing alcohol or cool water, or pour water on the body to reduce the temperature to a safe level (102°F). Observe the victim and obtain medical help. Do not give coffee, tea or alcoholic beverages.

Controls

Practice heat stress management:

- Workers should drink 16 ounces of water before beginning or restarting work after a break. Water should be maintained at 50 to 60 degrees Fahrenheit (°F). Workers should drink one to two 4-ounce cups of water every 30 to 60 minutes during work. The use of alcohol during non-working hours and the intake of caffeine during working hours can lead to an increase in susceptibility to heat stress. Monitor for signs of heat stress (shown in Heat Stress Conditions above).
- Workers should acclimate to site work conditions by slowly increasing workloads (i.e., do not begin site work activities with extremely demanding activities). This acclimation process may require up to two weeks.
- In hot weather, field activities should be conducted in the early morning or evening when temperatures are cooler. Rotate shifts of workers with potential heat stress exposure.
- Adequate shelter should be available to protect personnel from heat, which can decrease physical efficiency and increase the probability of heat stress. Erect temporary shade at the workstation if necessary. A cool area for rest breaks should be designated, preferably air-conditioned.
- Cooling devices should be used to aid natural body ventilation. Note: These devices add weight, and their use should be balanced against worker efficiency.

TICKS

Hazard Information

Ticks are generally found in wooded, brushy or grassy areas. They favor moist, shaded areas with fallen leaves and low vegetation. They often sit on the tips of tall grass or on shrubs waiting for a human or animal host to pass by.

There are a variety of ticks that can be found across the United States.

Adult ticks, which are approximately the size of sesame seeds, are most active from March to mid-May and from mid-August to November. Both nymphs and adults can transmit Lyme disease. Ticks can be active any time the temperature is above freezing.

Ticks burrow into the host´s skin using a barbed appendage in order to position themselves to withdraw blood. Infected ticks pass pathogens to the host through the bloodstream. Once imbedded, they may remain on the host for days. On humans, they frequently crawl to fleshy parts of the body and into difficult to reach spots such as the groin, armpit, or scalp. Some have been found burrowed into the navel or between toes.

Tick Removal

A fine-tipped tweezer is the recommended tick removal tool and should be in your first-aid kit. Follow these steps:

Pull upward with steady, even pressure. Do not twist or jerk the tick; this can cause mouth parts to break off and remain in the skin. If this happens, remove the parts with tweezers. If you are unable to remove the mouth parts easily with clean tweezers, leave them alone and let the skin heal.

After removing the tick, thoroughly clean the bite area and your hands with rubbing alcohol, an iodine scrub, or soap and water. Dispose of a live tick by submersing it in alcohol, placing it in a sealed bag/container, wrapping it tightly in tape, or flushing it down the toilet. Never crush a tick with your fingers. Do not attempt to use nail polish remover, petroleum jelly, lotion, or heat to try to get the tick to back out of your skin. Swift removal is the goal.

In the event a staff member is bitten by a tick, he/she needs to contact the H&A medical provider to initiate the tick management protocol. Once a tick has bitten a human host, it takes approximately 48 hours to transmit Lyme disease.

Controls

- Wear light-colored clothing so dark-colored ticks will stand out. Wear a long-sleeved shirt and long pants to reduce skin exposure. Tuck your shirt into your pants and tuck your pants into your socks to close gaps.
- Use repellent that contains 20 to 30% DEET on exposed skin and clothing. Avoid the hands, eyes, and mouth. Wash off the repellent when you return indoors.
- Treat or purchase clothing with products containing 0.5 percent permethrin. It will remain protective through several washings.
- While outdoors, conduct frequent tick checks on your clothing and skin. Have someone check your back, scalp, and behind your ears and joints. Check your gear for "hitchhikers."
- As soon as you return indoors, take a bath or shower (preferably within two hours) and do a full-body inspection using a hand-held or full-length mirror.
- Wash the clothes you wore outdoors and tumble them dry on high to kill any ticks that may be hidden in them.
- In the event that work is being conducted is an area of significant tick habitat, field staff may need to upgrade the level of PPE and don a Tyvek suit.
- Implementation of the controls is crucial to minimize or eliminate the possibility of a tick bite. Should a staff member find an embedded tick, he/she needs to report it immediately to Corporate H&S.
- In the event that a staff member has been bitten, contact Corporate H&S and Work Care at 888-449-7787 to initiate the Tick Management Protocol.

MOSQUITOES

Hazard Information

Work outdoors in weather with temperatures above freezing will most likely bring staff into contact with mosquitoes. There are a variety of mosquito species found throughout the country that can

transmit a range of diseases. The majority of mosquitoes are mainly a nuisance, but staff need to take appropriate precautions to minimize the potential transmission of a virus that can result in one of the following:

- WEST NILE VIRUS (WNV)
- EASTERN EQUINE ENCEPHALITIS VIRUS (EEEV)
- WESTERN EQUINE ENCEPHALITIS VIRUS (WEEV)

Outdoor workers should be aware that the use of personal protective equipment (PPE) and other protective/repellant techniques are essential to preventing mosquito bites especially when working at sites where mosquitoes may be active and biting.

Controls

- Use repellents containing DEET, picaridin, IR3535, and some oil of lemon eucalyptus and para-menthane-diol products provide longer-lasting protection. To optimize safety and effectiveness, repellents should be used per the label instructions.
- Cover as much of your skin as possible by wearing shirts with long sleeves, long pants, and socks whenever possible (use lightweight clothing to minimize the potential for heat-induced illnesses).
- Avoid use of perfumes and colognes when working outdoors during peak times (check to see when mosquitoes in your work area are most active as activity levels may depend on species and time of year) when mosquitoes may be active; mosquitoes may be more attracted to individuals wearing perfumes and colognes.

STINGING INSECTS

Hazard Information

Stinging insects include apidae (honeybees and bumblebees), and vespids (wasps, yellow jackets, and hornets. Apidae are docile and usually do not sting unless provoked. The stinger of the honeybee has multiple barbs, which usually detach after a sting. Vespids have few barbs and can inflict multiple stings.
Types of stinging insects that might be encountered on this project site may include:

- Carpenter bees
- Bumblebees
- Mud dauber wasps
- Honeybees
- Cicada killer wasps
- Giant hornets
- Paper wasps
- Yellow jackets

Generally, most stings will only result in a temporary injury: pain, swelling, and skin redness around the sting. However, sometimes the effects can be more severe, or even life-threatening, depending on where you are stung and what allergies you have. If you are stung on the throat, it may cause edema (swelling caused by fluid build-up in the tissues) around the throat and may make it difficult to breathe.

In rare cases, a severe allergic reaction can occur. This situation is serious and can cause anaphylaxis, also called anaphylactic shock. Symptoms of anaphylaxis can appear immediately (within minutes) or even up to 30 minutes later. Symptoms to watch for include:

- Hives, itching and swelling in areas other than the sting site
- Swollen eyes and eyelids
- Wheezing
- Tightness in the chest and difficulty breathing
- Hoarse voice or swelling of the tongue
- Dizziness or sharp drop in blood pressure
- Shock
- Unconsciousness or cardiac arrest

Anaphylaxis can occur the first time you are stung or sometimes with subsequent stings. Watch for signs of this reaction. If you see any signs of reaction, or even if you are not sure, call or have a co-worker call emergency medical services (e.g., 911) right away. Also, seek prompt medical attention if the sting is near the eyes, nose, or throat. Stay with the person who has been stung to monitor his/her reaction.

Controls

- Staff members who are allergic to bee stings are encouraged to inform their staff manager and project manager. If a staff member carries an EpiPen (i.e., epinephrine auto-injector), he/she is encouraged to inform his/her colleagues of how to use in the event that he/she is stung and becomes incapable of self-administering the injection.
- Examine the project site. Check to see if there are any visible signs of activity, or a hive or nest. If you see a number of insects flying around, check to see if they are entering/exiting from the same hole or place.
- Most bees and wasps will not sting unless they are startled or attacked. Do not swat at them or make fast movements. The best option is to let the insects fly away on their own. If you must, walk away slowly, or gently "blow" them away. The only exception is if you have disturbed a nest and hear "wild" buzzing. Protect your face with your hands and run from the area immediately.
- Wear long sleeve shirts, long pants, and closed-toed boots or shoes.
- Wear light-colored clothes such as khaki, beige, or blue. Avoid brightly colored, patterned, or black clothing.
- Tie back long hair to avoid bees or wasps from getting entangled in your hair.
- Do not wear perfumes, colognes, scented soaps, or powders as they contain fragrances that are attractive to bees.
- If you find a bee or wasp in your car, pull over as soon as it is safe and leave the windows open. You may also take a thick cloth and cover the insect before it gets frightened. Carefully, direct the insect back outside through an open window.

REMOTE

Hazard Information

Controls

POISONOUS SNAKES

Hazard Information

The possibility of encountering snakes exists, specifically for personnel working in wooded/vegetated areas. Snakes should be given a wide berth, as some may be poisonous. Many are non-venomous, but it is sometimes difficult to tell the difference until it is too late. Venomous snakes are found in each state and most bites occur between the months of April and October.

The effects produced by venoms include neurotoxic effects with sensory, motor, cardiac, and respiratory difficulties; cytotoxic effects on red blood cells, blood vessels, heart muscle, kidneys, and lungs; defects in coagulation; and effects from local release of substances by enzymatic actions. Other noticeable effects of venomous snake bites include swelling, edema, and pain around the bite, and the development of ecchymosis (the escape of blood into tissues from ruptured blood vessels).

To minimize the threat of snake bites, personnel traversing through vegetated areas need to be cognizant of the potential for encountering snakes and to avoid actions promoting encounters, such as turning over logs, etc. If a snake bite occurs, an attempt should be made to safely document the snake's appearance for identification purposes. First aid consists of applying a constriction band and washing the area around the wound to remove unabsorbed venom.

Symptoms

Signals that indicate a poisonous snake bite include:
•One or two distinct puncture wounds, which may or may not bleed - the exception is the coral snake, whose teeth leave a semicircular mark.
•Severe pain and burning at the wound site within 4 hours of the incident, if not immediately following the bite.
•Swelling and discoloration at the wound site within 4 hours of the incident, if not immediately following the bite.

Treatment
•If you have been bitten, remain calm and avoid unnecessary movement, especially if you have someone to assist you. The rate of venom distribution throughout your body will be slower if you are still and quiet.
•Do not use home remedies, and do not drink alcoholic beverages.

To care for a bite from a pit viper, such as a rattlesnake, copperhead, or cottonmouth, follow these steps:
•Call 9-1-1 or designated local emergency number (transport within 30 minutes of bite)
•Wash the wound

•Keep the injured area still and lower than the heart; if possible, carry a person who must be taken to a medical facility or have him or her walk slowly
•Do not apply ice
•Do not cut the wound
•Do not apply suction
•Do not apply a tourniquet

Controls

- Wear appropriate over-the-ankle hiking boots, thick socks, and loose-fitting long pants.
- Pay attention to the ground in front of you, watch where you step, and do not put your foot in or near a crevice where you cannot see inside.
- Be especially careful to watch out for snakes when climbing rocks.
- Upgrade PPE to include snake gaiters where snakes have been observed in the work zone.
- If you encounter a snake, stay calm, ensure you have proper footing behind you, and carefully step back.

Be sure to make other staff aware of what type of snake you encountered and where you saw it.

SMALL MAMMALS

Hazard Information

Rodents are highly prolific mammals. There are hundreds of species of rats alone; the most common are the black and brown rats. Rodents include rats, mice, beavers, squirrels, guinea pigs, etc.
Rats and mice often become a serious problem in cold winter months when they seek food and warmth inside buildings. They may suddenly appear in large numbers when excavation work disturbs their in-ground nesting locations or their food source is changed.
Some other major issues caused by mice and rats include:

- They eat food and contaminate it with urine and excrement.
- They gnaw into materials such as paper, books, wood, or upholstery, which they use as nest material. They also gnaw plastic, cinder blocks, soft metals such as lead and aluminum, and wiring, which may cause a fire hazard.
- Rats or mice may bite people while carrying diseases dangerous to humans.
    - Through their bites, diseases such as salmonella, trichinosis, rat bite fever, hanta virus, Weil´s disease, and the bubonic plague are spread.

Controls

- Look for any signs of rodent infestation and avoid any rodents that are observed.
    - Excrement/nesting materials may contain viruses.
    - Small mammals may carry plague-infested fleas.
    - Bird droppings may contain histoplasmosis.
- Avoid direct contact with and areas known to house potential rodent habitats, if possible.
- Avoid contact including ingestion of food or water with rodent excrement.

- Use dust control measures; if dust is anticipated, check with your Regional Health & Safety Manager (RHSM) regarding respiratory protection requirements.
- If exposed, wash hands and avoid touching your mouth, eyes, nose, etc. with your hands.
- Use a 10% bleach solution to clean contaminated items.
- Be aware of vector-borne disease exposure symptoms and seek treatment as soon as possible if exposure is suspected.

POISONOUS PLANTS

Hazard Information

Poisonous plants are a common hazard to watch out for in the warmer months because of field work is often increased during this time. Poisonous sap from these plants is an issue when the epidermis of a plant is ruptured and comes in contact with the skin. The risk for a reaction is greatest in the spring and early summer when the leaves are still tender. Most reactions will be a rash that occurs in 24-48 hours. If left untreated these rashes can last up to five weeks and possibly become extremely sensitive.
The most common types of poisonous plants are:

- Poison Oak (found in the South East and West coast of the U.S)
- Poison Sumac (found in the northern and southern regions of the U.S.)
- Poison Ivy (found everywhere in the U.S. except the west coast)

Poison Oak has leaves that look like oak leaves, usually with three leaflets, but sometimes may have up to seven leaflets per leaf group. It may grow as a vine or a shrub. Poison oak is more common in the western United States, but is also found in the eastern United States and, rarely, in the Midwest.

Poison Sumac has 7 to 13 leaflets per leaf stem. The leaves have smooth edges and pointed tips. Poison Sumac grows as a shrub or small tree. It is found in wooded, swampy areas, such as Florida and parts of other southeastern states, and in wet, wooded areas in the northern United States.

Poison Ivy usually has three or more broad, spoon-shaped leaves or leaflets. It may grow as a climbing or low, spreading vine that sprawls through grass (more common in the eastern United States) or as a shrub (more common in the northern United States, Canada, and the Great Lakes region).

All three plants will experience color changes over the course of three seasons. It is important to recognize the discoloration to prevent exposure. Staff members also need to be aware that exposure can also occur in the winter months as the plant stalks and "dead leaves" also contain poisonous sap.

Controls

- Wearing long sleeve shirts, pants, and gloves while walking through areas with poisonous plants can help keep the oils off of the skin; however, keep in mind that the clothing can still pick up the oils.

- Use a topical treatment to block the oils, such as Ivy Block? or Gardener´s Armor?.
- After returning from the site, remove all clothes and shoes that may have come into contact with a poisonous plant and wash them well.
- If you believe that you have come into contact with a poisonous plant, you should try to wash your skin as soon as possible.
- Field first aid kits also contain alcohol wipes which may also be used to remove the sap from the impacted area.
- To reduce itching after exposure to the oil:
    - To help relieve any itching, apply cotton cloths soaked in cool water to the area.
    - Apply calamine lotion, zinc oxide ointment, or a paste made with baking soda and water.
    - Take a bath with Aveeno colloidal oatmeal or similar treatment.
    - Take an over-the-counter antihistamine such as Benadryl or Chlor-Trimeton.
- A health-care profession should be seen if any of the following conditions exist:
    - Large areas of rash causing significant discomfort
    - A rash on the mouth, genitals, or around the eyes
    - An area of the rash that becomes infected or drains pus
    - A large amount of swelling
- Anaphylaxis
    - People who are highly sensitive to these plants can get a severe reaction called anaphylaxis.
    - If someone has swelling of the face and throat or difficulty breathing, feels dizzy or faint, or loses consciousness, he or she may be having an anaphylactic reaction.
    - If someone has any of these symptoms, take him/her immediately to a hospital emergency department.
    - Do not attempt to drive; call 911 for emergency medical treatment.
- **Reporting:** If the exposure occurred at work, be sure to submit a H&S Reporting Form through the Safety Site on HANK.

SLIPS AND TRIPS

Hazard Information

Slip and trip injuries are the most frequent injuries to workers. Both slips and trips result from some kind of unintended or unexpected change in the contact between the foot and the ground or walking surface. This shows that good housekeeping, quality of walking surfaces (flooring), awareness of surroundings, selection of proper footwear, and appropriate pace of walking are critical to preventing fall accidents.

Site workers will be walking on a variety of irregular surfaces that may affect their balance. Extra care must be taken to walk cautiously near any surfaces that are unfamiliar or may have unseen slip or trip hazards such as rivers because the bottom of the river bed maybe slick and may not be visible. Rocks, gradient changes, sandy bottoms, and debris may be present but not observable.

Controls

- Take your time and pay attention to where you are going.
- Adjust your stride to a pace that is suitable for the walking surface and the tasks you are doing.

- Check the work area to identify hazards - beware of trip hazards such as wet floors, slippery floors, and uneven surfaces or terrain.
- Establish and utilize a pathway free of slip and trip hazards.
- Choose a safer walking route.
- Carry loads you can see over and are not so heavy as to increase your trip/slip probability.
- Keep work areas clean and free of clutter.
- Communicate hazards to on-site personnel and mitigate hazards as appropriate.

ANIMAL DROPPINGS

Hazard Information

Project sites involving abandoned buildings may bring staff members into contact with animal droppings. There are a number of diseases that one can be exposed to from a variety of animals.

Mice and Rats

Hantaviruses are transmitted to humans from the dried droppings, urine, or saliva of mice and rats. The disease begins as a flu-like illness characterized by fever, chills, and muscle aches, but it can rapidly progress to a life-threatening condition marked by respiratory failure as the lungs fill with fluid. Animal laboratory workers and persons working in infested buildings are at increased risk for this disease, particularly during dusty clean-up activities.

Birds and Bats

Large populations of roosting birds may present a disease risk. The most serious health risks arise from disease organisms that grow in the nutrient-rich accumulations of bird droppings, feathers, and debris under a roost particularly if roosts have been active for years.

Among the fungal diseases associated with bird and bat droppings the two most common are histoplasmosis and cryptococcosis. Infection occurs when spores carried by the air are inhaled, especially after a roost has been disturbed. Most infections are mild and produce either no symptoms or a minor flu-like illness. On occasion, the disease can cause high fever, blood abnormalities, pneumonia, and even death.

Histoplasmosis is transmitted to humans by airborne fungus spores from soil contaminated by the droppings of birds and bats.

Controls

- Do not touch dropping with unprotected hands.
- Avoid disturbing the droppings and generating dust.
- Utilize employee work practices and dust control measures that eliminate or reduce dust generation during the removal of bat or bird droppings from a building, which will also reduce risks of infection and subsequent development of disease.
- Use an industrial vacuum cleaner with a high-efficiency (HEPA) filter to bag contaminated material.
- Wash your hands with warm water and soap after leaving a site with animal droppings.

Task Specific Hazards

TASK 1

Task 1 - Annual water sampling at selected groundwater monitoring wells on the EAL property and at nearby residential properties – Environmental water sampling could include activities such as groundwater sampling from permanent or temporary wells, or surface water sampling from streams, rivers, lakes, ponds, lagoons, and surface impoundments.
Sampling tasks could involve uncapping, purging (pumping water out of the well), and sampling, and/or monitoring, new or existing monitoring wells. A mechanical pump may be used to purge the wells and can be hand-, gas-, or electric-operated. Water samples taken from the wells are then placed in containers and shipped to an analytical laboratory for analysis. The physical hazards of these operations are primarily associated with the collection methods and procedures used.

When sampling bodies of water containing known or suspected hazardous substances, adequate precautions must be taken to ensure the safety of sampling personnel. The sampling team member collecting the sample should not get too close to the edge, where ground failure or slips, trips or falls may cause him/her to lose his/her balance. The person performing the sampling should have fall restraint or protection for the task. When conducting sampling from a boat in an impoundment or flowing waters, appropriate vessel safety procedures should be followed. Avoid lifting heavy coolers with back muscles; instead, use ergonomic lifting techniques, team lift or mechanical lifts. Wear proper gloves, such as when handling sample containers to avoid contacting any materials that may have spilled out of the sample containers.

Inhalation and absorption of COCs are the primary routes of entry associated with water sampling, due to the manipulation of sample media and equipment, manual transfer of media into sample containers, and proximity of operations to the breathing zone. During this project, several different groundwater sampling methodologies may be used based on equipment accessibility and the types of materials to be sampled. These sampling methods may include hand or mechanical bailing. The primary hazards associated with these specific sampling procedures are not potentially serious; however, other operations in the area or the conditions under which samples must be collected may present chemical and physical hazards. The hazards directly associated with groundwater sampling procedures are generally limited to strains or sprains from hand bailing, and potential eye hazards. Exposure to water containing COCs is also possible. All tools and equipment that will be used at the site must be intrinsically safe (electronics and electrical equipment) and non-sparking or explosion-proof (hand tools).

Potential Hazards			
Manual Lifting/Moving	Generated Waste	Slippery Surfaces	Heavy Equipment

TASK 2

Task 2 - Quarterly visual inspection of landfill gas vents LGV and perimeter water collection manholes – General hazards associated with site walk-throughs and site surveys include the following:

- Exposure to irritant and toxic plants such as poison ivy and sticker bushes may cause allergic reactions to personnel.
- Surfaces covered with heavy vegetation and undergrowth create a tripping hazard.
- Back strain due to carrying equipment, tools, and instruments.
- Native wildlife such as rodents, ticks, and snakes present the possibility of insect bites and associated diseases such as Lyme disease Driving vehicles on uneven or unsafe surfaces can result in accidents such as overturned vehicles or flat tires.
- Heat stress/cold stress exposure.

HAZARD PREVENTION

- Wear long-sleeved clothing and slacks to minimize contact with irritant and toxic plants and to protect against insect bites. Appropriate first aid for individuals? known allergic reactions.
- Be alert and observe terrain while walking to minimize slips and falls.
- Use proper lifting techniques to prevent back strain.
- Avoid wildlife when possible. In case of an animal bite, perform first aid and capture the animal, if possible, for rabies testing. Perform a tick check after leaving a wooded or vegetated area.
- Ensure all maintenance is performed on vehicles before going to the field. A site surveillance on foot might be required to choose clear driving paths.
- Implement heat stress management techniques such as shifting work hours, fluid intake, and monitoring employees, especially high risk workers.

- Performance of an on-site visit to view present conditions (chemical spill residue, die-back of vegetation, etc.); hazardous substances or petroleum products usage (presence of above ground or underground storage tanks, storage of acids, etc.); and evaluate any likely environmentally hazardous site history.
- Evaluation of risks of neighboring properties upon the subject property
- Review of Federal, State, Local and Tribal Records out to distances specified by the ASTM 1528 and AAI Standards (ranging from 1/8 to 1 mile depending on the database)
- Interview of persons knowledgeable regarding the property history (past owners, present owner, key site manager, present tenants, neighbors).
- Examine municipal or county planning files to check prior land usage and permits granted

Potential Hazards

TASK 3

Task 3 - Conduct annual landfill gas vents air monitoring, Record monthly leachate seepage collection and disposal volumes – General hazards associated with site walk-throughs and site surveys include the following:

- Exposure to irritant and toxic plants such as poison ivy and sticker bushes may cause allergic reactions to personnel.
- Surfaces covered with heavy vegetation and undergrowth create a tripping hazard.
- Back strain due to carrying equipment, tools, and instruments.
- Native wildlife such as rodents, ticks, and snakes present the possibility of insect bites and associated diseases such as Lyme disease Driving vehicles on uneven or unsafe surfaces can result in accidents such as overturned vehicles or flat tires.
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- Interview of persons knowledgeable regarding the property history (past owners, present owner, key site manager, present tenants, neighbors).
- Examine municipal or county planning files to check prior land usage and permits granted

Potential Hazards
Slippery Surfaces

Top Task Specific Hazards

Manual Lifting/Moving

Most materials associated with investigation, remediation, or construction-related activities are moved by hand. The human body is subject to damage in the forms of back injury, muscle strains, and hernia if caution is not observed in the handling process.

Controls

- Under no circumstances should any one person lift more than 49 pounds unassisted.
- Always push, not pull, the object when possible.
- Size up the load before you lift. Test by lifting one of the corners or pushing. If it is heavy or feels clumsy, get a mechanical aid or help from another worker. When in doubt, do not lift alone!
- Bend the knees; it is the single most important aspect of lifting.
- When performing the lift:
    - Place your feet close to the object and center yourself over the load
    - Get a good handhold
    - Lift straight up, smoothly and let your legs do the work, not your back!
    - Avoid overreaching or stretching to pick up or set down a load.
    - Do not twist or turn your body once you have made the lift.
    - Make sure beforehand that you have a clear path to carry the load.
    - Set the load down properly.

Generated Waste

Activities on environmental sites may generate waste that requires regulated handling and disposal.

Excess sample solids, decontamination materials, poly sheeting, used PPE, etc. that are determined to be free of contamination through field or laboratory screening can usually be disposed into client-approved, on-site trash receptacles. Uncontaminated wash water may be discarded onto the ground surface away from surface water bodies in areas where infiltration can occur. Contaminated materials must be segregated into liquids or solids and drummed separately for off-site disposal.

Controls

- Manage waste properly through good work practices.
- Collect, store, containerize waste, and dispose of it properly
- All wastes generated shall be containerized in an appropriate container (i.e., open or closed top 55-gallon drum, roll-off container, poly tote, cardboard box, etc.) as directed by the PM.
- Containers should be inspected for damages or defects.
- Waste containers should be appropriately labeled indicating the contents, date the container was filled, owner of the material (including address) and any unique identification number, if necessary.
- Upon completion of filling the waste container, the container should be inspected for leaks and an appropriate seal.

Slippery Surfaces

Both slips and trips result from unintended or unexpected change in the contact between the feet and the ground or walking surface. Good housekeeping, quality of walking surfaces (flooring), selection of proper footwear, and appropriate pace of walking are critical for preventing fall accidents.
Slips happen where there is too little friction or traction between the footwear and the walking surface. Common causes of slips are:

- wet or oily surfaces
- occasional spills
- weather hazards
- loose, unanchored rugs or mats
- flooring or other walking surfaces that do not have same degree of traction in all areas

Weather-related slips and falls become a serious hazard as winter conditions often make for wet or icy surfaces outdoors. Even wet organic material or mud can create treacherous walking conditions. Spills and leaks can also lead to slips and falls.

Controls

- Evaluate the work area to identify any conditions that may pose a slip hazard.
- Address any spills, drips or leaks immediately.
- Mark areas where slippery conditions exist.
- Select proper footwear or enhance traction with additional PPE.
- Where conditions are uncertain or environmental conditions result in slippery surfaces walk slowly, take small steps, and slide feet on wet or slippery surfaces.

Heavy Equipment

Staff members must be careful and alert when working around heavy equipment, since equipment failure or breakage and limited visibility can lead to accidents and worker injury. Heavy equipment such as cranes, drills, haul trucks, or other can fail during operation increasing the likelihood of worker injury. Equipment of this nature should be visually inspected and checked for proper working order prior to the commencement of field work. Those that operate heavy equipment must meet all of the requirements to operate heavy equipment. Haley & Aldrich, Inc. staff members that supervise projects or are associated with such high risk projects that involve digging or drilling should use due diligence when working with a construction firm.

See OP1052 Heavy Equipment for additional information.

Controls

- Only approach equipment once you have confirmed contact with the operator (e.g., the operator places the bucket on the ground).
- Maintain visual contact with operators at all times and keep out of the strike zone whenever possible.
- Always be alert to the position of the equipment around you.
- Always approach heavy equipment with an awareness of the swing radius and traffic routes of each piece of equipment and never go beneath a hoisted load.
- Avoid fumes created by heavy equipment exhaust.
- Understand the site traffic pattern and position yourself accordingly.

TASK PPE AND SAFETY EQUIPMENT

The personal protective equipment and safety equipment (if listed) is specific to the associated task. The required PPE and equipment listed must be on site during the task being performed. Work shall not commence unless the required PPE is present.

The purpose of PPE is to provide a barrier, which will shield or isolate staff members from the physical, biological, chemical, and/or radiological hazards that may be encountered during task activities.

Required PPE	**TASK 1**	**TASK 2**	**TASK 3**
	Annual Water Sampling	***LGV and MH Inspections***	***LGV monitoring and leachate seepage monitoring***
Hard hat	**x**	**x**	**x**
Safety glasses	**x**	**x**	**x**
Hard-toed Boots	**x**	**x**	**x**
Gloves	**x**	**x**	**x**
Long pants and 4" long sleeve shirt	**x**	**x**	**x**
Safety vest (Class 2)	**x**	**x**	**x**
Hearing Protection	**x**	**x**	**x**

TRAINING REQUIREMENTS

The table below lists the training requirements staff must have respective to their assigned tasks and that required to access the site.

Task Specific Training			
Required Training	**TASK 1**	**TASK 2**	**TASK 3**
	Annual Water Sampling	**LGV and MH Inspections**	**LGV monitoring and leachate seepage monitoring**
Site Required Training			
40 Hour Hazwoper			
8 Hour Hazwoper Refresher			
First Aid/CPR/AED			

SITE CONTROL

The overall purpose of site control is to minimize potential contamination of workers, protect the public from the site's hazards, and prevent vandalism. Site control is especially important in emergency situations. The degree of site control necessary depends on site characteristics, site size, and the surrounding community. The following information identifies the elements used to control the activities and movements of people and equipment at the project site.

Communication

Internal

H&A site personnel will communicate with other H&A staff member and/or subcontractors or contractors with:

- Face-to-Face Communication

External

H&S site personnel will use the following means to communicate with off-site personnel or emergency services.

- Cell Phones

ENVIRONMENTAL MONITORING

Monitoring procedures will be employed during project activities to assess employee exposure to contaminants. Monitoring will consist primarily of onsite determination of various parameters (e.g., airborne contaminant concentrations), but may be supplemented by more sophisticated monitoring techniques, if necessary.

Monitoring shall be performed within the work area on site in order to detect the presence and relative levels of contaminants. The data collected throughout monitoring shall be used to confirm or upgrade the defined levels of PPE identified within this plan. Monitoring shall be conducted as specified in the table below as work is performed.
Plan Name: Corning EAL Air Monitoring Plan

Parameter/ Contaminant	Equipment	Zone Location and Monitoring Interval	Action Level	Response Activity
Oxygen (O2)	Multi Gas Meter Manufacturer: RAESystems	Breathing zone while working. Also measure areas where explosive atmospheres may be present as LEL Detectors require at least 14% oxygen to work properly.	< 19.5% 19.5 - 23.5% >23.5%	Cease work and exit space or area. Requires supplied air. Contact H&S. Continue work in required PPE and continue monitoring Fire hazards - Cease work, exit, and contact H&S.
Explosive Atmospheres (LEL)	Multi Gas Meter Manufacture: RAESystems	All areas of work zone including elevated locations and low-lying areas. Pay particular attention to sources of ignition such as drill rigs and soil handling equipment	< 10% LEL > 10% LEL	Continue work in required PPE and continue monitoring Cease work, exit, and contact the H&SP and SSO.

Volatile Organic Compounds	Photo Ionization Detector Manufacturer with standard 10.6 lamp: RAESystems	Breathing zone and edge of Exclusion Zone.	Varies by COC. For most commonly encountered VOCs other than B,T,E,X, Vinyl Chloride and Vinylidene Chloride. < 10 ppm VOCs by PID > 10 ppm VOCs by PID for 5 minutes > 10 ppm VOCs by PID for > 5 minutes	 Continue work in required PPE and continue monitoring. Clear Instrument and Re-Monitor the Area. Implement PPE upgrades Evacuate the area and call the RHSM and/or PM for further guidance. Implement engineering controls.

Volatile Organic Compounds

Photoionization Detectors (PID) can be used to monitor VOC concentrations in work zones and/or at the site perimeter. These instruments do not give specific readings of contaminant concentration (e.g. benzene, TCE, etc.).

- Prior to the beginning of work obtain background readings with the PID away from the site.
- Monitor the breathing zone when site soil is exposed (e.g., while drilling or excavating is occurring, etc.) with the PID.
- Monitoring should be conducted most frequently (e.g., every 15-30 minutes) when drilling or excavation first begins in a particular area and when soil is removed from the hole. After this, and if no exceedances of exposure limits are noted (see below), monitoring may be conducted less frequently (e.g., every 30-60 minutes).
- H&A general exposure limits will be used when a mixture of potentially volatile chemicals are suspected to be present in soil at the site.

  In summary, if a reading of 10 ppm above background is detected with the PID for 5 minutes or longer, back away for a few minutes. Screen the air again after any vapors/gases have been given a chance to dissipate. If 10 ppm above background is still noted, evacuate the area and call the RHSM and/or PM for further guidance.

- Record monitoring data and PPE upgrades in field book or on Record of Field Monitoring form and maintain with project files.
- Air monitoring for exposure should be based on the frequency established under the Standard Air Monitoring Plan or under the Specific Monitoring Requirements. Record activity, time, location and results of monitoring and actions taken based upon the readings.

It is anticipated that exposure to VOCs can be mitigated during work operations as necessary to control dust emissions by means of limiting the area of exposed soils and through the use of water sprays. If VOCs cannot be controlled by these standard measures, additional measures may be employed such as the use of a vapor suppressant (if approved) to minimize soil exposures or by covering exposed soil and stockpiles with tarpaulins, plastic sheeting or geotextile fabric. Otherwise cease work immediately and contact the Project Manager or the Corporate Health & Safety Manager for assistance. It is not permissible for VOC emissions to escape from the site at any time and perimeter VOC monitoring may be required to insure public safety.

The H&A Site Health and Safety Officer (SHSO) will determine controls, up to and including PPE upgrades based upon visual determination as necessary and the occupational exposure limit, for each known or suspected contaminants.

SPILL CONTAINMENT

An evaluation was conducted to determine the potential for hazardous substance spills at this site. This evaluation indicates that there is no potential for a hazardous spill of sufficient size to require containment planning, equipment, and procedures.

DECONTAMINATION

All possible and necessary steps shall be taken to reduce or minimize contact with chemicals and contaminated/impacted materials while performing field activities (e.g., avoid sitting or leaning on, walking through, dragging equipment through or over, tracking, or splashing potential or known contaminated/impacted materials, etc).

Personal Hygiene Safeguards

The following minimum personal hygiene safeguards shall be adhered to:

1. **No smoking or tobacco products on site** or on any Hazwoper project.
2. No eating or drinking in the exclusion zone.
3. It is required that personnel present on site wash hands before eating, smoking, taking medication, chewing gum/tobacco, using the restroom, or applying cosmetics and before leaving the site for the day.
4. It is recommended that personnel present on site shower or bathe at home at the end of each day of working on the site.

Personal Decontamination

Outer gloves and boots should be decontaminated periodically as necessary and at the end of the day. Brush off solids with a hard brush and clean with soap and water or other appropriate cleaner whenever possible. Remove inner gloves carefully by turning them inside out during removal. Wash hands and forearms frequently. It is good practice to wear work-designated clothing while on-site which can be removed as soon as possible. Non-disposable overalls and outer work clothing should be bagged onsite prior to laundering. If gross contamination is encountered on-site contact the Project Manager and Regional Health and Safety Manager to discuss proper decontamination procedures.

The steps required for decontamination will depend upon the degree and type of contamination but will generally follow the sequence below.

1. Remove and wipe clean hard hat
2. Rinse boots and gloves of gross contamination
3. Scrub boots and gloves clean
4. Rinse boots and gloves
5. Remove outer boots (if applicable)
6. Remove outer gloves (if applicable)
7. Remove Tyvek coverall (if applicable)
8. Remove respirator, wipe clean and store (if applicable)
9. Remove inner gloves (if out gloves were used)

PPE that is not grossly contaminated can be bagged and disposed in regular trash receptacles

This decontamination procedure is applicable to Task(s) : 1

Decontamination Supplies

The following supplies and chemicals will be used to decontaminate any equipment requiring decontamination.

Equipment	
Alconox Soap	Brushes
Paper Towels	Tap water

EMERGENCY RESPONSE PLAN

Medical

If there is an injury or illness associated with an H&A staff member on the job-site stop work, stabilize the situation and secure the site. Assess the severity of the injury or illness to determine the appropriate course of action as listed below.

First Aid Injury

First aid will be addressed using the on-site first aid kit. H&A employees are not required or expected to administer first aid/CPR to any H&A staff member, Contractor, or Civilian personnel at any time and it is H&A´s position that those who do are doing it do so on their behalf and not as a function of their job.

- Injury or illness requiring clinic/hospital visit **WITHOUT** ambulance service

  Injuries or illnesses requiring hospital service without ambulance services include minor lacerations, minor sprains, etc. The following action will be taken:

  - The H&A SHSO will ensure prompt transportation of the injured person to the clinic or hospital identified in the safety plan.
  - Another H&A staff member, or contractor on-site, will always drive the injured staff member to the medical facility and remain at the facility until the staff member has been discharged. Staff members will not self-transport to the clinic or hospital.
  - If the injured staff member is able to return to the job site the same day, he/she will bring with him/her a statement from the doctor containing such information as:

- Date
- Employee´s name
- Diagnosis
- Date he/she is able to return to work, regular or light duty

- Date he/she is to return to doctor for follow-up appointment, if necessary
- Signature and address of doctor

- Injury or illness requiring a hospital visit **WITH** ambulance service

Injuries or illnesses requiring hospital service with ambulance services include severe head injuries, severe lacerations, heart attacks, heat stroke, etc. The following steps will be taken immediately:

- Call for ambulance service and notify the H&A SHSO.
- Comfort the individual until ambulance service arrives.
- While the injured employee is being transported, the H&A SHSO will contact the medical facility to be utilized.
- One designated representative will accompany the injured employee to the medical facility and remain at the facility until final diagnosis and other relevant information is obtained.

Notifications

For all injuries or illness notify the SHSO and PM who in turn will contact Corporate H&S. Within 24 hours the injured staff member or PM will complete the H&S Reporting Form found on HANK. Minor cuts, scratches, and bruises shall also be reported through the H&S Reporting Form. Notify the client in accordance with their notification protocol. Depending on severity, Human Potential will as promptly as possible following an injury or illness, ensure appropriate notification has been made to the family of the individual involved.

Severe Weather

Where the threat of electrical storms and the hazard of lightning exist, staff shall ensure that there is the ability to detect when lightning is in the near vicinity and when there is a potential for lightning and to notify appropriate site personnel of these conditions. The weather forecast will be checked on a daily basis and communicated at the daily safety tailgate meetings.

When lightning is detected or observed the information will be communicated to all crews in the field for appropriate action. Field supervisors will make the decision to stay put or to leave the work site. A location will be identified to marshal field staff in the event that staff are required to leave the job site. A similar decision process will be used during heavy rain events.

Staff shall seek appropriate shelter and not stay in the open

Evacuation Alarms

Verbal Communication will be used to communicate the evacuation alarm.

Emergency Services

Cellular phone will be used to contact Emergency Services.

Emergency Evacuation Plan

The site evacuation plan is as follows:

1. Establish a designated meeting area to conduct a head count in the event of an emergency evacuation.
2. If the work area is not near an emergency exit, exit via the closest route and meet at the designated meeting area.
3. Notify emergency response personnel (fire, police and ambulance) of the number of missing or unaccounted for employees and their suspected location.
4. Administer first aid will in the meeting area as necessary.

Under no circumstances should any personnel re-enter the site area without the approval of the corporate H&S manager, the H&S coordinator, and the fire department official in charge.

ROLES AND RESPONSIBILITIES

REGIONAL HEALTH AND SAFETY MANAGER (RHSM)

The Haley & Aldrich RHSM, Dave Nostrant, is a full-time Haley & Aldrich staff member, trained as a safety and health professional, who is responsible for the interpretation and approval of this Safety Plan. Modifications to this Safety Plan cannot be undertaken by the PM or the SSO without the approval of the RHSM.
Specific duties of the RHSM include:

- Approving and amending the Safety Plan for this project
- Advising the PM and SHSOs on matter relating to health and safety
- Recommending appropriate personal protective equipment (PPE) and air monitoring instrumentation
- Maintaining regular contact with the PM and SSO to evaluate the conditions at the property and new information which might require modifications to the HASP and
- Reviewing and approving JSAs developed for the site-specific hazards.

PROJECT MANAGER (PM)

The Haley & Aldrich PM, James, Siegfried, is responsible for ensuring that the requirements of this HASP are implemented at that project location. Some of the PM´s specific responsibilities include:

- Assuring that all personnel to whom this HASP applies have received a copy of it;
- Providing the RHSM with updated information regarding environmental conditions at the site and the scope of site work;
- Providing adequate authority and resources to the on-site SSO to allow for the successful implementation of all necessary safety procedures;
- Supporting the decisions made by the SHSO;
- Maintaining regular communications with the SSO and, if necessary, the RHSM;
- Coordinating the activities of all subcontractors and ensuring that they are aware of the pertinent health and safety requirements for this project;
- Providing project scheduling and planning activities; and
- Providing guidance to field personnel in the development of appropriate Job Safety Analysis (JSA) relative to the site conditions and hazard assessment.

SITE HEALTH & SAFETY OFFICER

The SHSO, [#SSHO#], is responsible for field implementation of this HASP and enforcement of safety rules and regulations. SHSO functions may include some or all:

- Act as H&A´s liaison for health and safety issues with client, staff, subcontractors, and agencies.
- Verify that utility clearance has been performed by H&A subcontractors.
- Oversee day-to-day implementation of the Safety Plan by H&A personnel on site.
- Interact with subcontractor project personnel on health and safety matters.
- Verify use of required PPE as outlined in the safety plan.

- Inspect and maintain H&A safety equipment, including calibration of air monitoring instrumentation used by H&A.
- Perform changes to HASP and document as needed and notify appropriate persons of changes.
- Investigate and report on-site accidents and incidents involving H&A and its subcontractors.
- Verify that site personnel are familiar with site safety requirements (e.g., the hospital route and emergency contact numbers).
- Report accidents, injuries, and near misses to the H&A PM and Regional Health and Safety Manager (RHSM) as needed.

The SHSO will conduct initial site safety orientations with site personnel (including subcontractors) and conduct toolbox and safety meetings thereafter with H&A employees and H&A subcontractors at regular intervals and in accordance with H&A policy and contractual obligations. The SHSO will track the attendance of site personnel at H&A orientations, toolbox talks, and safety meetings.

FIELD PERSONNEL

Haley & Aldrich personnel are responsible for following the health and safety procedures specified in this HASP and for performing their work in a safe and responsible manner. Some of the specific responsibilities of the field personnel are as follows:

- Reading the HASP in its entirety prior to the start of on-site work;
- Submitting a completed Safety Plan Acceptance Form and documentation of medical surveillance and training to the SHSO prior to the start of work;
- Attending the pre-entry briefing prior to beginning on-site work;
- Bringing forth any questions or concerns regarding the content of the Safety Plan to the PM or the SHSO prior to the start of work;
- Stopping work when it is not believed it can be performed safely;
- Reporting all accidents, injuries and illnesses, regardless of their severity, to the SHSO;
- Complying with the requirements of this safety plan and the requests of the SHSO; and
- Reviewing the established JSAs for the site-specific hazards on a daily basis and prior to each shift change, if applicable.

VISITORS

Authorized visitors (e.g., Client Representatives, Regulators, Haley & Aldrich management staff, etc.) requiring entry to any work location on the site will be briefed by the Site Supervisor on the hazards present at that location. Visitors will be escorted at all times at the work location and will be responsible for compliance with their employer´s health and safety policies. In addition, this safety plan specifies the minimum acceptable qualifications, training and personal protective equipment which are required for entry to any controlled work area; visitors must comply with these requirements at all times. Unauthorized visitors, and visitors not meeting the specified qualifications, will not be permitted within established controlled work areas.

APPENDICES

Appendix A - Task Hazards Summary (***Task summaries are included only if there is more than one task)***

Task 1

Task 2

Task 3

Task 4

Appendix B – Permits and Forms

Appendix C – Safety Data Sheets

Appendix D – Operating Procedures

Appendix E – Covid-19 Safety Precautions

Appendix E
HASP Amendment Form

This Appendix is to be used whenever there is an immediate change in the project scope that would require an amendment to the HASP. For project scope changes associated with "add-on" tasks, the changes must be made in the body of the HASP. Before changes can be made, a review of the potential hazards must be initiated by the H&A Project Manager.

Amendment No.	2
Site Name:	Corning Edward Allen Landfill
Work Assignment No.:	
Date:	19, March 2020
Type of Amendment:	Health and Safety
Reason for Amendment:	Covid-19 outbreak
Alternate Safeguard Procedures:	Social distancing and extra precautions with practices of good hygiene. Disinfection of shared items. New safety tailgate and self-declaration forms. See Mike Weaver's best practices and fact sheets, hard copies attached to hard copy of site HASP.
Required Changes in PPE:	Hand sanitizer or access to soap and hot water

Project Manager Signature: _____ Date: _____

Local Health and Safety Coordinator: _____ Date: _____

This original form must remain on site with the original HASP. If additional HASPs are in the field, it is the Project Manager's responsibility to forward a signed copy of this amendment to those who have copies.


Fact Sheet Disinfection


Fact Sheet Hygiene


COVID-19 Addendum


Safety Tailgate Form


Self-Declaration Form

MONITORING PLAN AND EQUIPMENT

Is air/exposure monitoring required at this work site for personal protection? ☑ Y ☐ N

Is perimeter monitoring required for community protection? ☐ Y ☑ N

Monitoring/Screening Equipment **Requirements:**

Check all items that are required to be on site.

Required Monitoring/Screening Equipment

- ☐ Photo-Ionization Detector (PID) 10.2eV
- ☐ Photo-Ionization Detector (PID) 11.7eV
- ☑ Photovac Micro Tip (PID) 10.6eV
- ☐ Organic Vapor Monitor (FID)
- ☐ Photovac Gas Chromatagraph (GC)
- ☐ Combustible Gas Indicator (CGI) (LEL)
- ☐ Multiple Gas Detector LEL/O2/H2S/CO
- ☐ Dust Monitors (RAMs)
- ☐ Colorimetric tubes
- ☐ Other

The required equipment checked in any box above must be on site. Work shall not commence unless the equipment is present.

Standard Action Levels and Required Responses:

Exposure Guidelines for common contaminants are listed in Table 1 - Occupational Exposure Limits in the Chemical Hazards section above.

Requirements for PPE upgrades based on monitoring are in Table 2 - Monitoring Methods, Action Levels and Protective Measures following the Specific Monitoring Requirements section below.

Action levels for readings obtained with a multiple gas detector are listed below.

Instrument	Normal	Operating levels	Action levels – required responses
Oxygen Meter	20.9%	Between 19.5-23.5%	Below 19.5 %: leave area, requires supplied air Above 23.5%: leave area, fire hazard
CGI	0%	Less than 10%	Greater than 10%: fire/explosion hazard; cease work
Hydrogen Sulfide	0%	Less than 10 ppm.	Greater than 15 ppm (or 10 ppm for 8 hrs) requires supplied air respirator
Carbon Monoxide	0%	Less than 25 ppm	Greater than 200 ppm for 1 hour (or 25 ppm for 8 hrs) requires supplied air respirator

TABLE 2
Last Revised September 2002

MONITORING METHOD, ACTION LEVELS AND PROTECTIVE MEASURES

INSTRUMENT	HAZARD	ACTION LEVEL	ACTION RESPONSE
Respirable Dust Monitor	Total Particulates	> 5 mg/m^3	Upgrade to Level C Protection
OVA, HNU[2], Photovac Microtip	Total Organic Vapors	Background	Level D Protection
		10 ppm > background or lowest OSHA permissible exposure limit, whichever is lower, or as modified for this task. Sustained for >5 minutes in the breathing zone.	Upgrade to Level C - site evacuation may be necessary for specific compounds
		50 ppm over background, unless lower values required due to respirator protection factors	Cease work; upgrade to Level B[3] may be required
Explosimeter[4] (LEL)	Flammable/Explosive Atmosphere	<10% Scale Reading	Proceed with work
		10-15% Scale Reading	Monitor with extreme caution
		>15% Scale Reading	Evacuate site
0xygen Meter[5]	Oxygen-Deficient Atmosphere	19.5% - 23.5% 0_2	Normal - Continue work
		< 19.5% 0_2	Evacuate site; oxygen deficient
		> 23.5% 0_2	Evacuate site; fire hazard
Radiation Meter[6]	Ionizing Radiation	0.1 Millirem/Hour	If > 0.1, radiation sources may be present[7]
		> 1 Millirem/Hour	Evacuate site; radiation hazard
Drager Tubes	Vapors/Gases	Species Dependent > 1 ppm vinyl chloride > 1 ppm benzene > 1 ppm 1,1-DCE	Consult Table 1 or other resources for concentration toxicity/detection data. Upgrade to Level C if concentration of compounds exceed thresholds shown at left; May need to cease work if other levels exceeded - site specific
Gas Chromatograph (GC)	Organic Vapors	3 ppm total OV > background or > lowest specific OSHA permissible exposure limit, whichever is lower	On-site monitoring or tedlar bag sample collection for off-site/laboratory analysis

Notes:
1. Monitor breathing zone.
2. Can also be used to monitor some inorganic species.
3. Positive pressure demand self contained breathing apparatus
4. Lower explosive limit (LEL) scale is 0-100%. LEL for most gasses is 15%.
5. Normal atmospheric oxygen concentration at sea level is 20%
6. Background gamma radiation is ~0.01-0.02 millirems/hour.
7. Contact H&A Health and Safety staff immediately.

HAZARD ASSESSMENT SUMMARY			
Project Name:	Corning Edward Allen	**Project Number:**	129773
Site Address:	Bailey Creek Road Corning, New York		
Health & Safety Plan Prepared by:	McKenna, Santa	**Date:**	02-14-2018
Task:	Task 1		
Task Description:	Water Sampling		
Task Start Date	03-05-2018	**Task End Date:**	

POTENTIAL HAZARDS DURING THIS TASK

Hazards	Actions to Eliminate or Minimize Hazards

Manual Lifting/Moving	• Under no circumstances should any one person lift more than 49 pounds unassisted.
	• Always push, not pull, the object when possible.
	• Size up the load before you lift. Test by lifting one of the corners or pushing. If it is heavy or feels clumsy, get a mechanical aid or help from another worker. When in doubt, do not lift alone!
	• Bend the knees; it is the single most important aspect of lifting.
	• When performing the lift:
	  ○ Place your feet close to the object and center yourself over the load
	  ○ Get a good handhold
	  ○ Lift straight up, smoothly and let your legs do the work, not your back!
	  ○ Avoid overreaching or stretching to pick up or set down a load.
	  ○ Do not twist or turn your body once you have made the lift.
	  ○ Make sure beforehand that you have a clear path to carry the load.
	  ○ Set the load down properly.

Generated Waste	• Manage waste properly through good work practices. • Collect, store, containerize waste, and dispose of it properly • All wastes generated shall be containerized in an appropriate container (i.e., open or closed top 55-gallon

	drum, roll-off container, poly tote, cardboard box, etc.) as directed by the PM. • Containers should be inspected for damages or defects. • Waste containers should be appropriately labeled indicating the contents, date the container was filled, owner of the material (including address) and any unique identification number, if necessary. • Upon completion of filling the waste container, the container should be inspected for leaks and an appropriate seal.
Slippery Surfaces	• Evaluate the work area to identify any conditions that may pose a slip hazard. • Address any spills, drips or leaks immediately. • Mark areas where slippery conditions exist. • Select proper footwear or enhance traction with additional PPE. • Where conditions are uncertain or environmental conditions result in slippery surfaces walk slowly, take small steps, and slide feet on wet or slippery surfaces.
Heavy Equipment	• Only approach equipment once you have confirmed contact with the operator (e.g., the operator places the bucket on the ground). • Maintain visual contact with operators at all times and keep out of the strike zone whenever possible. • Always be alert to the position of the equipment around you. • Always approach heavy equipment with an awareness of the swing radius and traffic routes of each piece of equipment and never go beneath a hoisted load. • Avoid fumes created by heavy equipment exhaust. • Understand the site traffic pattern and position yourself accordingly.

HAZARD CONTROL MEASURES USED DURING THIS TASK

Task Trainings:	NA
Permits and Forms:	
PPE Requirements	Hard hat Safety glasses Hard-toed Boots Gloves

	Long pants and 4" long sleeve shirt Safety vest (Class 2) Hearing Protection

HAZARD ASSESSMENT SUMMARY					
Project Name:	Corning Edward Allen			**Project Number:**	129773
Site Address:	Bailey Creek Road Corning, New York				
Health & Safety Plan Prepared by:	McKenna, Santa			**Date:**	02-14-2018
Task:	Task 2				
Task Description:	Site Walk				
Task Start Date	03-05-2018		**Task End Date:**		

POTENTIAL HAZARDS DURING THIS TASK	
Hazards	**Actions to Eliminate or Minimize Hazards**

HAZARD CONTROL MEASURES USED DURING THIS TASK	
Task Trainings:	NA
Permits and Forms:	
PPE Requirements	Hard hat Safety glasses Hard-toed Boots Gloves Long pants and 4" long sleeve shirt Safety vest (Class 2) Hearing Protection

HAZARD ASSESSMENT SUMMARY

Project Name:	Corning Edward Allen	**Project Number:**	129773
Site Address:	Bailey Creek Road Corning, New York		
Health & Safety Plan Prepared by:	McKenna, Santa	**Date:**	02-14-2018
Task:	Task 3		
Task Description:	Site Walk		
Task Start Date	03-05-2018	**Task End Date:**	

POTENTIAL HAZARDS DURING THIS TASK

Hazards	Actions to Eliminate or Minimize Hazards
Slippery Surfaces	• Evaluate the work area to identify any conditions that may pose a slip hazard. • Address any spills, drips or leaks immediately. • Mark areas where slippery conditions exist. • Select proper footwear or enhance traction with additional PPE. • Where conditions are uncertain or environmental conditions result in slippery surfaces walk slowly, take small steps, and slide feet on wet or slippery surfaces.

HAZARD CONTROL MEASURES USED DURING THIS TASK

Task Trainings:	NA
Permits and Forms:	
PPE Requirements	Hard hat Safety glasses Hard-toed Boots Gloves Long pants and 4" long sleeve shirt Safety vest (Class 2) Hearing Protection

HAZARD ASSESSMENT SUMMARY					
Project Name:	Corning Edward Allen			**Project Number:**	129773
Site Address:	Bailey Creek Road Corning, New York				
Health & Safety Plan Prepared by:	McKenna, Santa		**Date:**	02-14-2018	
Task:	Task 4				
Task Description:	Soil Sampling				
Task Start Date	03-05-2018	**Task End Date:**			

POTENTIAL HAZARDS DURING THIS TASK	
Hazards	**Actions to Eliminate or Minimize Hazards**

HAZARD CONTROL MEASURES USED DURING THIS TASK	
Task Trainings:	NA
Permits and Forms:	
PPE Requirements	Hard hat Safety glasses Hard-toed Boots Gloves Long pants and 4" long sleeve shirt Safety vest (Class 2) Hearing Protection

HASP Addendum
COVID-19

Safety
in everything we do

HEALTH & SAFETY FACTSHEET

Incorporate the following into the HASP Addendum to protect field staff, business partners, clients and the general public at project sites:

•COVID-19 is part of H&S planning and will be risk assessed prior to MOB and approved by the Field Safety Manager.

•If we are not the controlling employer, ensure we understand what the project is doing for COVID-19 mitigation methods prior to mobilization.

•***Fit for Duty*** – All employees, subcontractors (if subcontracted to H&A), and visitors (f H&A is controlling employer) will sign the Self Declaration form at the start of the project. Daily Fit for Duty signing of the tailgate form will reaffirm this information.

•Do not come to the site if you are sick, if you have been in close personal contact with someone with symptoms of COVID-19, have visited, or come in contact with someone who has visited a high-risk area for COVID-19.

•If others come to the site with COVID-19 symptoms, isolate yourself from them and ask them to leave or notify the Controlling Employer.

•Cleaning/Sanitizing/Disinfecting

- •If a job trailer is present, See Fact Sheet for further guidance on Field Trailer Cleaning and Disinfection.
- •Clean and disinfect rental vehicles and hotel spaces. *(See Fact Sheet)*

•Personal Hygiene

•Handwashing should happen after using restrooms, before and after eating, coming onsite, and going offsite. If handwashing equipment isn't available, hand sanitizing products should be used. *(See Fact Sheet)*

•Avoid touching face (eyes, nose, mouth) at all times, even when wearing gloves. *(See Fact Sheet)*

The risk associated with potential exposure to COVID-19 will be considered as part of the project planning and HASP development cycle

Have H&S review the HASP

Business partners for sites managed by H&A (H&A controlling employer) will have completed the Self Declaration Form

Approved and appropriate Personal Protective Equipment and supplies are used as indicated by the HASP

HALEY ALDRICH

HASP Addendum
COVID-19

Safety
in everything we do

HEALTH & SAFETY FACTSHEET

Does the client or controlling employer (if H&A is not controlling employer) have specific requirements related to COVID-19? Y N

If yes, please attach the requirements

Do we have the necessary supplies on hand? Y N

(Supplies includes disinfectant wipes, hand washing stations or sanitizer, PPE)

The following must be provided:

Has the Field Guidance Hygiene Fact Sheet been provided? Y

Has the Field Cleaning and Disinfectant Fact Sheet been provided? Y

Has the Self Declaration form been completed by all H&A subs? Y

Has the Travel Fact Sheet been provided? Y N/A

COVID-19 PROJECT SPECIFIC JOB HAZARD ANALYSIS

HAZARD	CONSEQUENCE	MITIGATION METHODS

HALEY ALDRICH

Health & Safety Tailgate Meeting Form

Project:	Project No.:
Location:	Project Manager:
Subcontractor(s):	Date:
Site Safety & Health Officer (SSHO):	SSHO Contact Info:

Emergency Procedures

If an emergency occurs, follow procedure outlined in the HASP and contact numbers below. If non-life-threatening injury occurs, contact PM to report the incident. Seek first-aid treatment from the Occupational Health Center, as outlined in the HASP.

Emergency Dispatch phone number if other than 911:	
Local Hospital:	Local Hospital Phone #:
Evacuation/Muster Point:	Alt Evacuation/Muster Point:

Simultaneous Operations (SIMOPS)

SIMOPS or Multi-Crew Activity	☐ Yes	☐ No	If yes, describe SIMOPS:	
Has SIMOPS been communicated to all workforce?	☐ Yes	☐ No		
SIMOPS PIC:			**Phone Number:**	

Task Identification

Task	**Responsible Company**	**Task Supervisor**

Required Permits/Forms (*check all that apply*)

☐None	☐Lifting Plan	☐Other:
☐Confined Space Entry Permit	☐Hot Work Permit	☐Other:
☐Lock-out / Tag-out (LOTO)	☐Ground Disturbance Permit	☐Other:
☐Excavation Permit	☐Other:	☐Other:

Discussion of Work Hazards *(check all that apply)*

☐Chemical	☐Hazardous materials (lead, asbestos, etc.)	☐Radiological
☐Confined space	☐Hosting and rigging	☐Stored energy LOTO
☐Congested work area	☐Hot work	☐Traffic control
☐Elevated work	☐Material handling	☐Weather and/or temp extremes
☐Ergonomics	☐Noise pollution	☐Waste generation
☐Emergency egress	☐Oxygen deficiency	☐Other:

Required PPE *(check all that apply)*

										
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Hearing Protection	Safety Eyewear	Hard Hat	Safety Toed Shoes	Leather or Palm Protective	Safety Vest	Protective Clothing	Respiratory Protection	PFD	Face Shield	Fall Protection

HALEY ALDRICH

Tailgate Topic / Hazard Discussion

Item	Discussion

Management of Change (MoC)

Does the work activity require a MoC? If yes, has it been authorized by applicable management? ☐No ☐Yes
Has the safety information been updated to incorporate any change in product, equipment, material or process? This information should include how to investigate accidents, audit compliance with safety procedures, and plan for emergency responses. ☐No ☐Yes
Have the procedures for a MoC been reviewed and evaluated? ☐No ☐Yes
Have all affected staff been informed and trained on the new equipment, process, or other changes? Health and safety hazards must be emphasized including processes/procedures in an emergency. The training must occur before any staff is allowed to operate the equipment or perform the job relating to the changes. ☐No ☐Yes
Have written procedures been put into place for the next time there is a change in safety management? ☐No ☐Yes

Best Practice(s) Observed? ☐ Yes ☐ No If yes, describe:	**H&S Observations/ Near Misses/ Incidents Reported?** ☐ Yes ☐ No If yes, describe:
Safe Work Interventions? ☐ Yes ☐ No If yes, describe:	**Have additional hazards and risk controls been identified for future work?** ☐ Yes ☐ No If yes, update appropriate job hazard analysis (JHA).

Site Safety & Health Officer Acknowledgement

At the conclusion of the day, I certify that the work site has been inspected and is being left in a safe and clean condition and any incidents have been properly reported.

Signature Date

Worker Acknowledgement

By signing here, you are stating the following:

1. You understand the hazards and risk control actions associated with each task you are about to perform.
2. You understand the permit to work requirements pertinent to the work you are about to perform (if applicable).
3. You are aware that no tasks or work that is not risk-assessed is to be performed.
4. You also are aware of your obligation to implement 'Safe Work'.
5. You arrived and departed fit for duty.
6. You are physically and mentally fit for duty.
7. You are not under the influence of any type of medication, drugs, or alcohol that could affect your ability to work safely.
8. You are aware of your responsibility to bring any illness, injury (regardless of where or when it occurred), or fatigue issue you may have to the attention of the SSHO.
9. You signed out uninjured unless you have otherwise informed the SSHO.

Name (print)	Company	Initials & Sign In/Out Time		COVID-19 Self-Declaration
		In & Fit	Out & Fit	On File

Visitor Log (*Site Visitors not involved in the work activities*)

Name (print)	Company	Initials & Sign In/Out Time		COVID-19 Self Declaration
		In & Fit	Out & Fit	On File

COVID-19 Self-Declaration Form

The safety of our employees, customers, families and visitors remains Haley & Aldrich's overriding priority. As the coronavirus disease 2019 (COVID-19) outbreak continues to evolve and spreads globally, we are monitoring the situation closely and will periodically update company guidance based on current recommendations from the Center for Disease Control and the World Health Organization.

To prevent the spread of COVID-19 and reduce the potential risk of exposure to our employees and others, we are conducting a simple screening questionnaire. Your participation is important to help us take precautionary measures to protect you and everyone in this building. Thank you for your time.

Name:	Personal Phone Number (mobile/home):
Company/Organization:	Haley & Aldrich Point of Contact:
Facility Name:	

If the answer is "yes" to any of the following questions, access to the facility will be denied.

	Self-Declaration
1	Have you returned from any of the countries listed on www.cdc.gov within the last 14 days? ☐ Yes ☐ No
2	Have you had close contact with or cared for someone diagnosed with COVID-19 within the last 14 days? ☐ Yes ☐ No
3	Have you been in close contact with anyone who has traveled within the last 14 days to one of the countries listed on www.cdc.gov? ☐ Yes ☐ No
4	Have you experienced any COVID-19 symptoms in the last 14 days (to include fever, cough, difficulty breathing)? ☐ Yes ☐ No

Signature: _____ Date: _____

Note: If you plan to be onsite for consecutive days, please immediately advise your Haley & Aldrich point of contact if any of your responses change.

Access to facility/project site (circle one): Approved Denied

Fact Sheet
COVID-19 Field Guidance -Hygiene

Safety
in everything we do

HEALTH & SAFETY FACTSHEET

When performing field work, employ the following good hygiene practices:

- Practice social distancing – stay 6' away from other people. If possible, avoid use of shared site/job trailers. If shared spaces need to be utilized see Field Trailer Cleaning and Disinfection Guide.
- If you can, bring your own food to the site and avoid restaurants and food trucks to reduce potential exposure pathways.
- Cover your mouth when you cough or sneeze by using a tissue that you immediately discard into a waste container or cough or sneeze into the inside of your elbow.
- Wash your hands routinely with each change of glove or use hand sanitizer with greater than 60% alcohol. Wash hands or use hand sanitizer after each time you cough or sneeze.
- If you are wearing gloves, remove them immediately after coughing or sneezing and discard in a waste receptacle.
- Avoid touching your face throughout the day.
- Do not insert single use ear plugs with gloves on. Disinfect hands and then insert ear plugs.
- Do not come to work or to the site if you are sick or exhibiting any symptoms of COVID-19.
- If another person on site does come into work or to the site sick, isolate them, and send them home if H&A is the controlling employer. If H&A is not the controlling employer, isolate yourself from the person, and inform the controlling employer accordingly.
- Carry disinfectant from the EPA list with you and wipe down surfaces you touch prior to starting work and routinely throughout the day, including rental cars and hotel spaces as appropriate.
- Clean and disinfect all supplies (pens, clipboards, etc.), tablets, cellphones, reusable equipment (meters, pumps, etc.), and non-disposable PPE (hardhats, safety glasses, earmuffs) at the end of each day.
- Do not reuse single use PPE such as ear-plugs and nitrile gloves.

- Change and discard gloves routinely and after each time you cough or sneeze (see Fact Sheet, Glove Removal)

- Wash hands or use hand sanitizer with more than 60% alcohol immediately after removing gloves

- Avoid touching your face (eyes, nose, mouth), even when wearing gloves

https://www.epa.gov/pesticide-registration/list-n-disinfectants-use-against-sars-cov-2

HALEY ALDRICH

Fact Sheet COVID-19
Field Guidance – Glove Removal

Safety
in everything we do

HEALTH & SAFETY FACTSHEET

Use PPE, specifically use nitrile gloves, to prevent contact with germs on surfaces.

Remove gloves carefully to prevent contamination and dispose in a waste container.

HALEY ALDRICH

Fact Sheet Coronavirus (COVID 19)
Field Trailer Cleaning and Disinfecting Guide

Safety
in everything we do

HEALTH & SAFETY FACTSHEET

If you can avoid using Site/Project common spaces to eliminate the shared surfaces hazard, please do so. If not follow these steps:

- For Haley & Aldrich controlled site trailers, the Site Safety Officers are responsible for cleaning all common areas within a field trailer.
- If H&A employees have work areas in a shared field trailer controlled by others, obtain information from controlling employer on sanitation practices. H&A Site Safety Officer is responsible for cleaning all H&A assigned spaces as outlined below.
- To clean, use disinfectants found on the EPA list. Disinfecting refers to products that kill germs and lowers the risk of spreading infection. If you are not currently using a disinfectant on these surfaces, please purchase them.
- Labels contain instructions for safe and effective use of the product including precautions you should take when applying the product, such as wearing gloves (Personal Protective Equipment) and making sure you have good ventilation during use of the product. Gloves should be discarded after each cleaning and disinfection.
- Provide disposable disinfecting wipes for staff to use on commonly used surfaces (for example, keyboards, desks, etc.), which can be wiped down by staff at their own workstations. Throw disinfecting wipes away after one use.
- Have hand sanitizer available at your common areas for staff use. Post the WHO Hand Rubbing poster near sanitizers.
- If job trailers are not controlled by H&A, we recommend staff wear disposable nitrile gloves while accessing commons spaces (opening doors, copy areas, shared desks) to limit potential exposures in areas controlled by others.

Routinely clean (at least once per day) and disinfect all frequently touched surfaces in the workplace such as desktops, refrigerators, microwaves, coffee makers, doorknobs, etc.

Use approved cleaners and disinfectants as directed. Ensure proper personal protective equipment is used. Throw away disposable items after each use such as gloves and disinfecting wipes.

Provide hand sanitizers, soap and disinfectants to employees, business partners, and visitors for personal use, and encourage everyone to clean their desks, phones, cell phones, chairs, etc.

HALEY ALDRICH

Fact Sheet
Coronavirus (COVID 19) Cleaners and Disinfectants – EPA Approved

HEALTH & SAFETY FACTSHEET

EPA has an approved list of cleaners and disinfectants for the coronavirus that causes COVID-19.

Many are common cleaners and disinfectants that may already be used in our offices, project sites, and in your homes.

Check the updated list here:

https://www.epa.gov/sites/production/files/2020-03/documents/sars-cov-2-list_03-03-2020.pdf

To assist in managing project trailer cleaning and disinfection, we have reserved this space for location specific information.

Insert hand sanitizer, cleaners, and disinfectants used at this location and where they can be found:

- Clorox wipes
- Clorox multi-surface cleaner
- Purell hand sanitizer at reception, kitchen, printer, etc.

3rd Party cleaning and disinfection company:

- [ABC Cleaning] - check with landlord to determine cleaning and disinfecting practices

Schedule of cleaning and disinfection practices:

- [Daily- all kitchen appliances, countertops, conference rooms all door handles]

APPENDIX B

Equipment Information

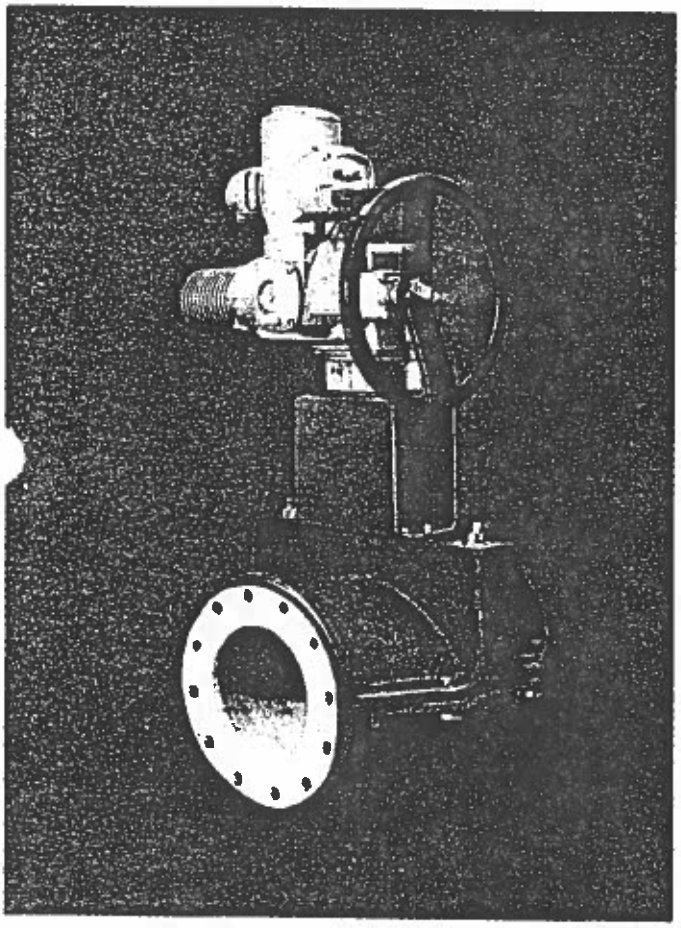
EQUIPMENT INFORMATION

Section 15103

Red Valve® Company, Inc.

SERIES 5200E

Electric Actuated Control Pinch Valve



Installation, Operation, and Maintenance Manual

The Red Valve Series 5200E Electrically Actuated Control Pinch Valve is a bi-directional valve designed for tough slurry applications. The elastomer sleeve closes on entrapped solids in the line. The flexing action of the sleeve breaks up any sediment or build-up in the valve, which makes the Series 5200E a reliable, low maintenance valve.

A variety of elastomers are available to suit your specific needs. Along with the standard Red Valve sleeve, we offer Cone, Variable Orifice, Reduced Port, and Double Wall sleeves for special applications.

- Simple design
- No Packing to maintain, ever
- Cost effective
- No cavities or dead spots to bind valve operation
- Low maintenance

IMPORTANT

Please take a moment to **review this manual.** The improper installation or use of this product may result in personal injury, product failure, or reduced product life. Red Valve Co., Inc. can accept NO liability resulting from the improper use or installation of this product. If you have any questions or problems, please call the customer service hotline at (412) 279-8464. We appreciate your comments. And thank you for choosing Red Valve.

GENERAL DESCRIPTION

The Red Valve Series 5200E Electrically Operated Control ·ch Valve consists of four major components:

1. **Body** The body acts as a housing and support for the other valve components. It is not the primary pressure containing component.
2. **Sleeve** The sleeve is the primary pressure containing component and is the only component in contact with the process fluid.
3. **Mechanism** In sizes up to 3", the mechanism consists of a top pinch bar connected to an ACME threaded stem. In sizes 4" and larger, the pinching mechanism consists of a top and a bottom pinch bar guided and supported by side rails. The top pinch bar is connected to an ACME threaded stem.
4. **Electric Actuator** The electric actuator rotates a bronze nut (threaded to match the mechanism stem) with an electric motor via reduction gears. It also has a de-clutchable handwheel override. The actuator is equipped with torque and limit switches to prevent damage by shutting off the actuator if torque or stroke limits are exceeded. For modulating applications, the actuator accepts the standard ISA 4-20 mA input signal.

INSTALLATION

Series 5200Es have standard ANSI B16.1 Class 125 flanges which are equivalent to ANSI B16.5 Class 150 flanges. Due to clearances, the valves have tapped holes instead of through holes. **CAUTION**: Do not use bolts that are too long, as they may bottom out and crack the body. Stud bolts are recommended.

2. The flanges mating to the Series 5200E should be serrated approximately 1/16" x 90°. Rubber will creep along smooth metal, PVC, or Teflon flanges, eventually causing a leak. Flange I.D. should match the sleeve I.D. and should be free of sharp edges which could cut into sleeve flanges. Weld neck or socket weld flanges are recommended. Slip on or screw on flanges have a larger I.D. and can cut the rubber sleeve. If slip on or screw on flanges must be used, grind off all sharp I.D. edges.
3. Do not use sharp tools, such as screwdrivers or crow bars, on the rubber during installation. This can cut and damage the flange face and cause possible leakage.
4. The valve should be completely open before installing the valve in the pipeline or tightening the flange bolts. Valve sizes 10" and larger are "D-Ported" and have a pre-pinch at the bottom of the sleeve. Tighten all flange bolts to values listed in the table on the back page. You will not overtorque the flange rubber.

   flanges leak during operation, open the valve and retighten the flange bolts. Stroke the valve closed and then reopen and retighten the flange bolts.
6. Connect all electrical wiring as shown in the electric actuator manual included with these instructions.

OPERATION AND ADJUSTMENT

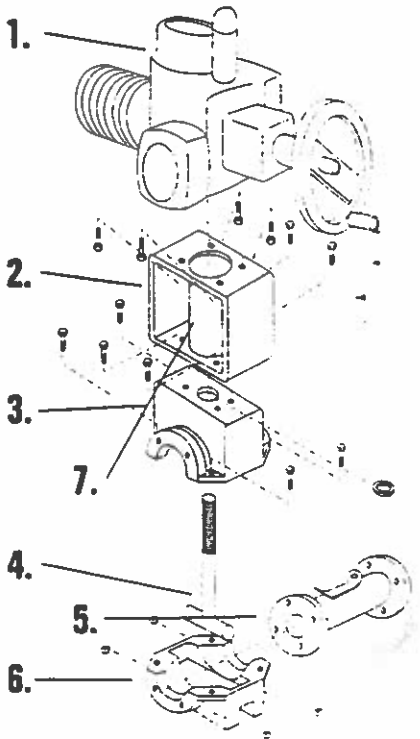
1. Operate the handwheel override to close the valve approximately halfway. Energize the actuator to open the valve and observe if the valve opens or closes. If the valve is going in the wrong direction, the wiring from the power source is not connected properly. **STOP IMMEDIATELY!** See the electric actuation manual for details of corrective action.

   If the direction of operation is correct, cycle the valve completely closed and completely open to verify smooth operation and complete stroking. The torque and limit switches and position indicator have been factory preset and normally do not need to be adjusted. If readjustment becomes necessary, follow the instructions in the electric actuator manual.
2. For both on-off and modulating valves, be certain the valve is closed completely and not cracked open in the closed position.

   Operating the valve in a cracked open position can shorten sleeve life, since flow velocities are very high under these conditions. For valves 4" and larger, if the valve cannot be closed completely, the lower pinch bar can be raised by turning the adjusting nuts on the top of the guide rails clockwise. First, loosen the jam nuts, then turn the lower adjusting nut on each side rail one to two turns in the clockwise (tightening) direction. Be sure to turn each nut an equal amount. Check for complete closure of the valve. If necessary, repeat these steps until the valve seals completely. Finally, tighten the jam nuts, being careful not to disturb the setting of the adjusting nuts.
3. A spare sleeve should be placed on order when this valve is placed in service.

PARTS – Series 5200E 3" and Under

1. Actuator
2. Mounting Bracket
3. Body Top
4. Pinching Mechanism
5. Sleeve
6. Body Bottom
7. Grease Fitting



MAINTENANCE

1. **Lubrication** The valve mechanism and actuator were completely lubricated during final assembly and testing at the factory, and do not need to be lubricated at start-up. The valve should be lubricated every thirty days thereafter using a high quality lithium grease. Grease fittings are located as follows:

   1. On the Electric Actuator (see Electric Actuator Manual)
   2. Inside the top mounting bracket on the stem protector

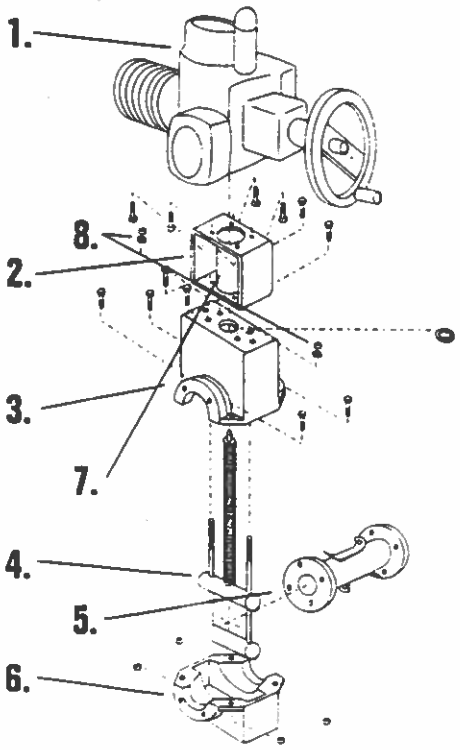
   In addition, the stem protector on top of the actuator should be removed and the grease in the lower cavity around the stem should be replenished as needed.

2. **Sleeve Replacement** **WARNING:** Be sure to flush all hazardous material and bleed all pressure from the pipeline before proceeding!

   1. Open the valve completely. Valve sizes 10" and larger are "D-Ported" and have a pre-pinch at the bottom of the sleeve.
   2. Remove the valve from the pipeline.
   3. Disassemble the body by removing the body bolts and remove the lower half of the body.
   4. Remove the old sleeve by unfastening the positive opening tabs, collapsing one flange, and pulling the sleeve through the mechanism.
   5. Slide the new sleeve through the mechanism and repeat the above steps in reverse order. Be sure the flange bolt holes in the sleeve line up with the bolt holes in the body flange before bolting the two halves together. **Note:** For Cone and Variable Orifice Sleeves, be sure that the sleeve is oriented correctly with the flange marked "Inlet" on the upstream side of the valve, to insure proper operation of the valve.

PARTS – Series 5200E 4" and Over

1. Actuator
2. Mounting Bracket
3. Body Top
4. Pinching Mechanism
5. Sleeve
6. Body Bottom
7. Grease Fitting
8. Adjusting Nuts and Jam Nuts



MISCELLANEOUS

Reduced Port or Pre-Pinched Valves When replacing either a Reduced Port or Pre-Pinched sleeve in Series 5200E Valves, the pinching bars must be spaced at their original setting (Consult factory for details if this is not clear).

Returns All returns must have standard Red Valve Company return goods tags. Sleeves to be inspected by Red Valve Company must have the tag firmly attached to the sleeve via the bolt holes, and must list the company, order number, address, valve serial number, your telephone number, operating temperature, pressure, closing frequency, fluid media, and total days in service.

Important: If the product being returned has been in contact with a hazardous chemical or material, an MSDS (Material Safety Data Sheet) must be provided with the return paperwork; otherwise, the return will not be processed.

DOUBLE WALL SLEEVES have triple life expectancy on severe abrasion. The extra thickness requires the next larger flange size on the valve body.

It is recommended that the sleeve I.D. be the same as the pipe I.D. (Fig. 1) This will require that a reducing flange be purchased, or an oversize mating flange be installed on the pipe. This is easily done by using blind flanges and boring the I.D. to suit the existing pipe. For example, on a 6" flange, 4" bore Double Wall valve, the mating flange would be a 6" blind flange bored out to slip over the 4" pipe (approximately 4-1/2" dia.).

If it is not possible to match the pipe and sleeve I.D. as described above, the flanges will mate and the sleeve I.D. will protrude into the pipeline (Fig. 2). To prevent bulging and premature breaking of the Double Wall Sleeve, a steel washer must be installed as shown (Fig. 3). The steel washer should be 1/8" thick and be serrated on the side facing the sleeve. The washer O.D. can be just short of the bolt holes, or it can equal the flange O.D. and bolt holes can be drilled through the washer.

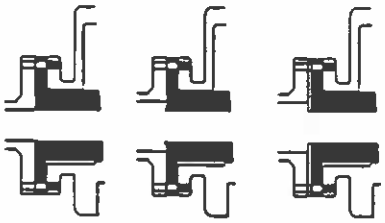


FIG. 1 FIG. 2 FIG. 3

STORAGE

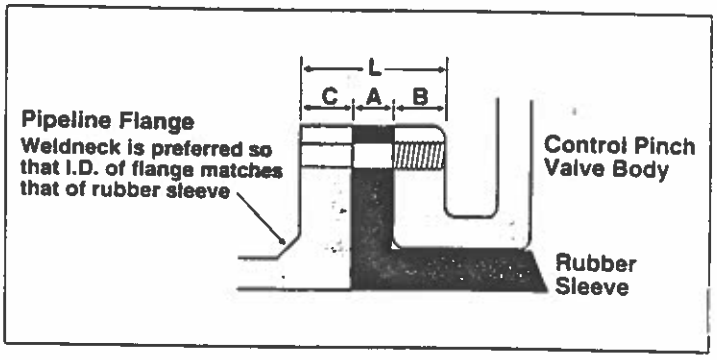
If your Series 5200E Control Pinch Valve is to be stored for a period of time prior to installation, the following guidelines will help preserve the valve and assure trouble-free installation.

1. Store valve and spare sleeves in a cool, clean, dry location.
2. Avoid exposure to light, electric motors, dirt, or chemicals. Resilient sleeves are subject to rapid deterioration when exposed to ozones and certain chemicals.
3. Grease stem liberally and store valve in the full open position. Do not stack other items on top of the valve.
4. Store Installation Operation and Maintenance Manual with the valve so it will be readily available for installation.

SERIES 5200E FLANGE BOLTING SPECIFICATIONS

VALVE SIZE	NO. OF BOLTS	BOLT CIRCLE DIAMETER	THREAD SIZE	L	A	B	C	BOLT TORQUE (ft. lbs)
1"	4	3-1/8"	1/2" - 13 NC	1-9/16"	1/2"	1/2"	9/16"	20
1-1/2"	4	3-7/8"	1/2" - 13 NC	1-7/8"	1/2"	11/16"	11/16"	30
2"	4	4-3/4"	5/8" - 11 NC	2"	1/2"	3/4"	3/4"	50
2-1/2"	4	5-1/2"	5/8" - 11 NC	2-1/4"	1/2"	7/8"	7/8"	60
3"	4	6"	5/8" - 11 NC	2-9/16"	3/4"	7/8"	15/16"	70
4"	8	7-1/2"	5/8" - 11 NC	2-11/16"	3/4"	1"	15/16"	50
5"	8	8-1/2"	3/4" - 10 NC	2-5/8"	3/4"	15/16"	15/16"	60
6"	8	9-1/2"	3/4" - 10 NC	3-1/8"	1"	1-1/8"	1"	80
8"	8	11-3/4'	3/4" - 10 NC	3-1/4"	1"	1-1/8"	1-1/8"	90
10"	12	14-1/4"	7/8" - 9 NC	3-3/8"	1"	1"	5/16"	70
12"	12	17	7/8" - 9 NC	3-1/2"	1"	1-1/4"	1-1/4"	100
14"	12	18-3/4	1" - 8 NC	3-3/4"	1"	1-3/8"	1-3/8"	100
16"	16	21-1/4	1" - 8 NC	3-7/8"	1"	1-7/16"	1-7/16"	70
18"	16	22-3/4"	1-1/8" - 7 NC	4-11/16"	1-1/2"	1-5/8"	1-9/16"	90
20"	20	25"	1-1/8" - 7 NC	4-15/16"	1-1/2"	1-3/4"	1-11/16"	90
24"	20	29-1/2"	1-1/4" - 7 NC	5-3/8"	1-1/2"	2"	1-7/8"	110

- Torque values are suggested minimum values.
- Torque all flange bolts in a star pattern. First to 50% of tabulated values, then re-torque to 100% of tabulated values. If greater torque is required, continue re-torquing in increments of 50% of tabulated values.
- Variables such as surface finish on bolt threads, type of anti-seize compound used, and surface finish of the mating flanges all have an effect on the minimum torque required to obtain a leak tight flange seal.
- Use of a high quality anti-seize compound on all bolt threads is recommended.



RED VALVE WARRANTY

WARRANTIES - REMEDIES - DISCLAIMERS - LIMITATION OF LIABILITY
Unless otherwise agreed to in writing signed by Red Valve, all Products supplied by Red Valve will be described in the specifications set forth on the face hereof.

THE WARRANTIES SET FORTH IN THIS PROVISION ARE EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES WHETHER STATUTORY, EXPRESS OR IMPLIED (INCLUDING ALL WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE AND ALL WARRANTIES ARISING FROM COURSE OF DEALING OR USAGE OR TRADE).

Red Valve Products are guaranteed for a period of one year from date of shipment, against defective workmanship and material only, when properly installed, operated and serviced in accordance with Red Valve's recommendations. Replacement for items of Red Valve's manufacture will be made free of charge if proved to be defective within such year; but not claim for transportation, labor or consequential damages shall be allowed. We shall have the option of requiring the return of the defective product to our factory, with transportation charges prepaid, to establish the claim and our liability shall be limited to the repair or replacement of the defective product, F.O.B. our factory. Red Valve will not assume costs incurred to remove or install defective products nor shall we incur backcharges or liquidated damages as a result of warranty work. Red Valve does not guarantee resistance to corrosion erosion, abrasion or other sources of failure, nor does Red Valve guarantee a minimum length of service, or that the product shall be fit for any particular service. Failure of purchaser to give prompt written notice of any alleged defect under this guarantee forthwith upon its discovery, or use, and possession thereof after an attempt has been made and completed to remedy defects therein, or failure to return product or part for replacement as herein provided, or failure to install and operate said products and parts according to instructions furnished by Red Valve, or failure to pay entire contract price when due, shall be a waiver by purchaser of all rights under these representations. All orders accepted shall be deemed accepted subject to this warranty which shall be exclusive of any other or previous warranty, and shall be the only effective guarantee or warranty binding on Red Valve, anything on the contrary contained in purchaser's order, or represented by any agent or employee of Red Valve in writing or otherwise, not withstanding implied warranties. RED VALVE MAKES NO WARRANTY THAT THE PRODUCTS, AUXILIARIES AND PARTS ARE MERCHANTABLE OR FIT FOR ANY PARTICULAR PURPOSE.

Red Valve®
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Pittsburgh, PA 15106
(412) 279-0044
FAX (412) 279-7878

Section 15103

rotork actuation

Instruction manual for 'A' Range actuators

Syncropak 1400 series
Syncropak 1600 series
Syncroset

Health and Safety

This manual is produced to enable the user to install, operate, adjust, inspect and maintain Rotork A range valve actuators.

For the UK the electrical installation, maintenance and use of these actuators should conform to the requirements of the Electricity (Factories Act) Special Regulations 1908 and 1944 and the guidance given in the 15th edition of the IEE Wiring Regulations. The user should therefore make himself familiar with these regulations and other Statutory Provisions relating to the safe use of this equipment. Also the user should be fully aware of his duties under the Health and Safety at Work etc. Act 1974.

The mechanical installation should be carried out as outlined in the manual and also in accordance with the relevant British Standard Codes of Practice.

If the actuator has nameplates indicating that the actuator is suitable for installation in Hazardous Gas Areas then the following regulations apply. The electrical installation, maintenance and use of these actuators should be carried out in accordance with BS 5345 Part 1: 1976 and BS 5345 Part 3: 1979. No inspection or repair should be undertaken unless it conforms to the requirements given in these standards, and under no circumstances should any modification or alteration be carried out on the actuator as this could very well invalidate the conditions under which the certificate was granted.

These actuators are suitable for use in Zone 1 and Zone 2 explosive atmospheres only, and they should not be installed in atmospheres where Group II C gases are present, or where gases are present with an ignition temperature less than 135°C. Unless suitability for lower ignition temperatures has been indicated on the actuator nameplate. Any test instruments applied to the actuator should be of equivalent certification.

Access to live electrical conductors of the actuator is forbidden in the hazardous area unless this is done under a special permit to work as described in Section 3 of the manual, otherwise all power should be isolated and the actuator removed to a non hazardous area for repair or attention.

Only persons competent by virtue of their training and experience should be allowed to install, maintain and repair these actuators, and they should carry out this work in accordance with the instructions given in the manual. The user and those persons working on this equipment should be familiar with their responsibilities under the Health and Safety at Work etc. Act 1974 and relevant Statutory Provisions relating to their work.

For installations outside the UK the requirements of local regulations should be observed.

Should further information and guidance relating to the safe installation, maintenance and use of the Rotork A Range actuator be required, this will be provided on request.

If your actuator cannot be installed immediately store it in a dry place until required and do not remove transit plugs until you are ready to wire up.

The Rotork double sealed construction will preserve internal electrical components perfectly if left undisturbed.

Rotork cannot accept responsibility for deterioration caused on site once the actuator covers are removed.

Every Rotork actuator has been fully tested before leaving the factory to give you years of trouble free operation providing it is correctly installed and sealed.

1 Operating your Rotork actuator
1.1 Operating by hand
1.2 Operating electrically
1.3 Valve position indication

2 Preparing the drive bush (type A + AZ)
2.1 Removing drive bush
2.2 Replacing drive bush
2.3 Removing drive bush (type AR + AE)

3 Mounting actuator on valve or gearbox
3.1 Rising stem valves, top mounting
3.2 Valve gearboxes, side mounting
3.3 Non-rising stem valves, top mounting
3.4 Handwheel sealing

4 Wiring up
4.1 Ground connections
4.2 Removing terminal cover
4.3 Sealing conduit entries
4.4 Connecting terminals
4.5 Replacing terminal cover

5 Setting instructions
5.1 Switch mechanism
5.1.1 How to check if your actuator has already been properly set
5.1.2 Setting the limit switches to operate at either end of valve stroke
5.1.3 Selecting torque or limit control
5.1.4 How to select torque values
5.1.5 How to replace switch mechanism cover

5.2 Optional extras
5.2.1 Setting intermediate auxiliary switches (AOP1only)
5.2.2 Setting the potentiometer
5.2.3 Setting the Current Position transmitter (CPT)
5.2.4 Blinker
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6.3 Syncropak actuators (1600 series)
6.4 Syncroset actuator

7 Trouble shooting
7.1 Syncropak actuators
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8.2 Oil fill/drain plugs
8.3 Maintenance
Appendix 1

9 Service and spares
Details of sub-assemblies available. List of major worldwide service centres.

Rotork Syncroset actuators

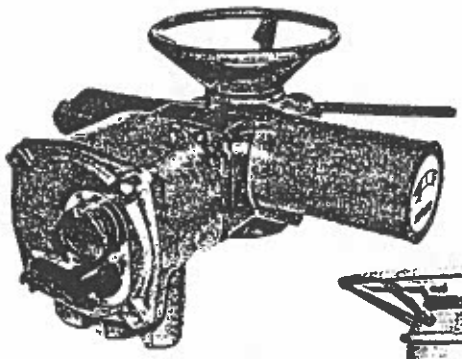
Each standard Syncroset consists of four basic sub-assemblies:

a Motor

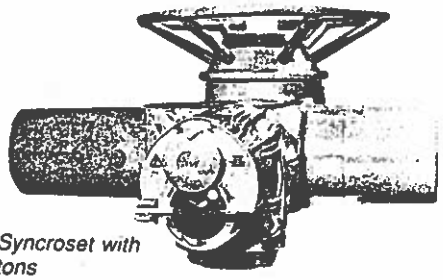
b Oil-filled worm gearbox with handwheel and declutch mechanism

c Limit and torque switch mechanism

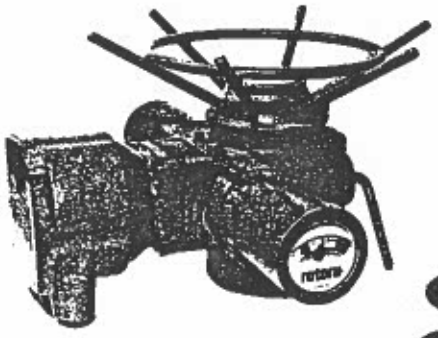
d Terminal box



Standard Syncroset with pushbuttons



Integral Syncroset with pushbuttons



Standard Syncroset

Integral Syncroset

Rotork Syncropak actuators

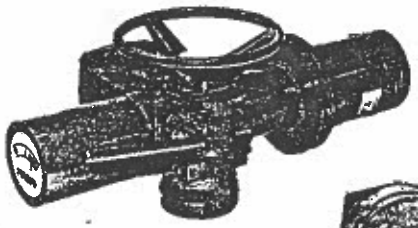
Each standard Syncropak consists of four basic sub-assemblies:

a Motor

b Oil-filled worm gearbox with handwheel and declutch mechanism

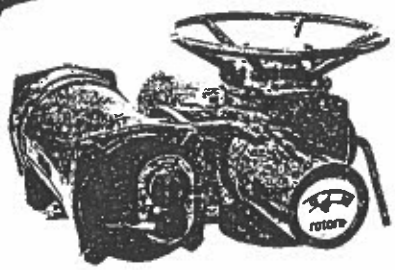
c Limit and torque switch mechanism

d Integral starter and associated control equipment



Syncroset DC

Standard Syncropak (or Flameproof Syncroset with Pushbuttons)



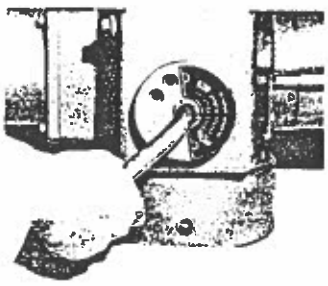
1 Operating your Rotork actuator

Throughout this publication you will be referred to procedures which will require you to operate your actuator either by hand or electrically.

Actuators must not be allowed to run valve to end of travel until correct motor rotation has been established.

Both operations are simple. The various controls which you will need to use are as follows.

1.1 Operating by hand



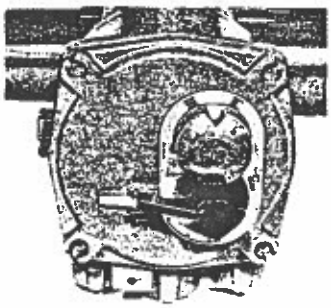
To engage handwheel, depress clutch lever into 'hand' and turn handwheel to engage clutch. The lever can now be released.

The hand drive will remain engaged until the actuator is operated electrically when it will automatically disengage the handwheel and return to 'auto'. If required the clutch lever can be secured in either position with a 5/16" diameter hasp padlock.

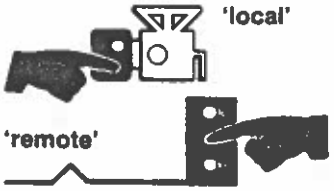
1.2 Operating electrically

Selecting local or remote control (Syncropak only):

The black selector switch located on the starter cover can be turned to select any one of three control positions: 'local', 'remote' or 'stop'.



On 1600 series, 'local' and 'remote' are represented by the following symbols:



When selecting 'stop' note that the selector switch lever rides over and automatically depresses the red pushbutton into the 'stop' position.

Any position can be maintained by using a 1/4" diameter hasp padlock.

To open or close the valve or stop the actuator:

The red pushbutton on the starter cover has two functions: push to stop, turn to start, in either direction.

1.3 Valve position indication

Valve position is indicated mechanically by pointer and dial and, when live, by indicator lamp on Syncropak unit as follows:

valve position	illumination	symbol
open	red	
intermediate	white	
shut	green	

Note that the pointer stays central during valve travel. When Add-on-pak 1 is fitted, pointer movement is continuous between 'shut' and 'open'. (see section 4.6).

2 Preparing the drive bush

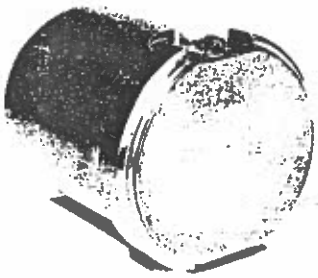
Rotork actuators are supplied fitted with a drive bush which can be detached for machining to suit the valve stem.

2.1 Removing drive bushes on actuator types A and AZ

Engage hand and turn handwheel until retainer set screw is visible through hole in actuator base.

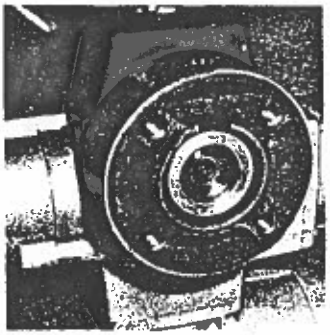
Loosen set screw and unscrew retainer using hammer and punch. Remove drive bush and machine to suit valve stem or gearbox input shaft.

Allow apparently excessive clearance on screw thread for old rising stem valves.



Type A drive bush

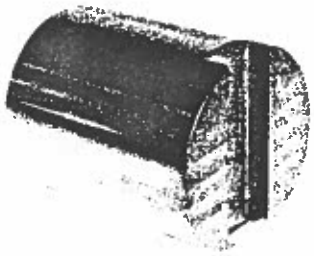
If the actuator has a type A drive bush, this can be fitted in position 1 or 2 to suit the position of the valve mounting flange.



Type A drive bush in position 1

Type A drive bush in position 2

If it has a type AZ drive bush this can only be fitted below the actuator base to give the maximum stem diameter acceptance.



Type AZ drive bush

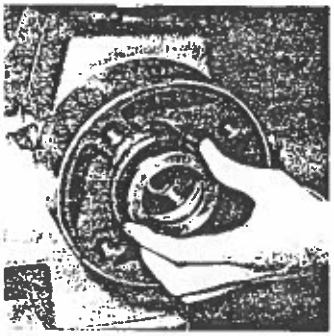
Type AZ drive bush in position 3

3 Mounting actuator on valve or gearbox

2.2 Replacing drive bush

Having confirmed the position secured, insert the machined drive bush ensuring that the actuator output shaft dogs are in full engagement with the bush.

Fit drive bush retainer securely, turning clockwise until fully tightened using hammer and punch. Rotate by handwheel to align retainer set screw with hole in base and lock tight.



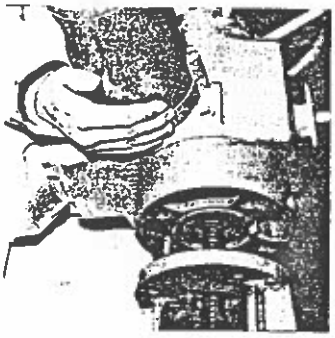
2.3 Removing drive bush on actuator types AR and AE

These drive bushes are retained in the actuator without screwed retainers.

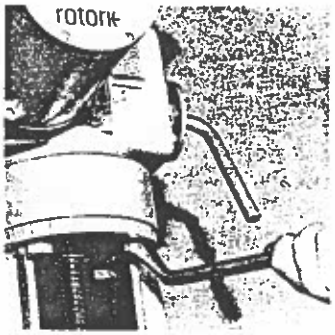
Actuator to remain fully supported until full spindle engagement has been acheived and actuator base is located to valve flange, and secured.

It is assumed that the valve has a mounting flange to suit the actuator.

3.1 Rising stem valves, top mounting



Lower the actuator on to the valve stem, engage 'hand' and wind the handwheel in the opening direction to engage the thread on the valve stem. Continue winding until the actuator is firmly down on the valve yoke. Wind two further turns of the output shaft.

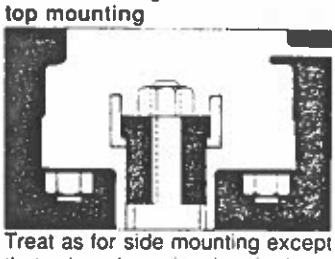


Fit securing screws or nuts and tighten fully.

3.2 Valve gearboxes, side mounting

Check that the valve mounting flange is at right angles to the input shaft, and that the drive bush fits the shaft and keyway with adequate axial tolerance. Engage 'hand', offer up actuator to the input shaft and turn handwheel to align keyway and key. Bolt up tight.

3.3 Non-rising stem valves, top mounting



Treat as for side mounting except that, when thrust is taken in the actuator, the thrust nut above the drive bush must be securely tightened.

3.4 Handwheel sealing

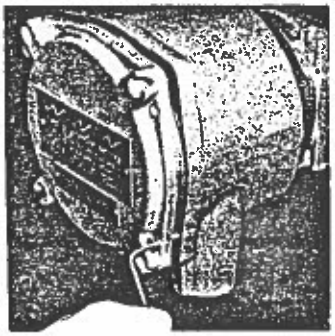
Ensure that sealing plug in centre of h/w or spindle cover tube (depending on which is fitted) is sealed with PTFE tape and fully tightened, ensuring that moisture does not pass down the centre column of the actuator.

Check that supply voltage agrees with that stamped on actuator nameplate.

4.1 Ground connections

A lug with 1/4" diameter hole is cast adjacent to the conduit entries for attachment of an external earthing strap by nut and bolt. An internal earthing terminal is also provided.

4.2 Removing terminal cover



Use two of the cover retaining screws in the jacking holes.

Do not attempt to lever off with screwdriver as this will spoil 'O' ring seal and may damage the flame path on a certified unit.

Note the wiring code card fixed inside the cover. This is particular to each actuator and must not be interchanged with any other actuator. If in doubt check serial number on nameplate with that on code card.

Unscrew earthing terminal nut and remove plastic bag containing wiring diagram, terminal nuts and spare 'O' rings.

3 Sealing conduit entries

Conduit entries should be sealed in accordance with surrounding environment and with any requirements of the regulatory authority.

Seal unused entries with screwed metal plugs. Do not use plastic plugs if supplied with actuator.

4 Connecting terminals

Refer to the wiring diagram inside the terminal cover to identify functions of terminals. Check that supply voltage is the same as marked on the code card and actuator nameplate.

Remove transparent power terminal screen, and begin wiring the power terminals.

Note: Syncroset and Syncropak 1400 series

Correct phase rotation is essential for electrical operation and must be checked at start-up stage. All Rotork Syncroset and Syncropak 1400 series 3 phase actuators are tested for correct operation with phase rotation in terminal order 1, 2, 3.

4.5 Replacing terminal cover

Check that serial number on code card is the same as on the actuator nameplate before replacing cover with its 'O' ring in position.

5 Setting instructions

5.1 Switch mechanism

There are two basic operations which have to be carried out:

1 Setting the switches to operate at either end of the valve's stroke.

2 Selecting the correct 'torque' or 'limit' function for your particular valve and possibly adjusting the torque value for your particular application.

If you have already received a complete motorized valve these operations should already have been carried out.

5.1.1 How to check if your actuator has already been properly set

With the actuator firmly bolted to the valve engage handwheel drive.

Fully open the valve by hand and check that the position indicator pointer moves over to the 'open' position just before the handwheel reaches its stop.

Fully close the valve by hand and check that the pointer moves over to the 'shut' position just as the valve seats.

If the indicator is reading correctly at both ends of stroke, you can assume that your valvemaker has already carried out the detailed setting instructions which follow and you can proceed directly to Section 6 Start-up.

If you have bought your actuator separately from the valve or if the check was negative you must now go through the following procedure.

5.1.2 Setting the limit switches to operate at either end of valve stroke

Note: Instructions are for 'clockwise closing'. For anticlockwise' read 'opening' as 'closing' etc.

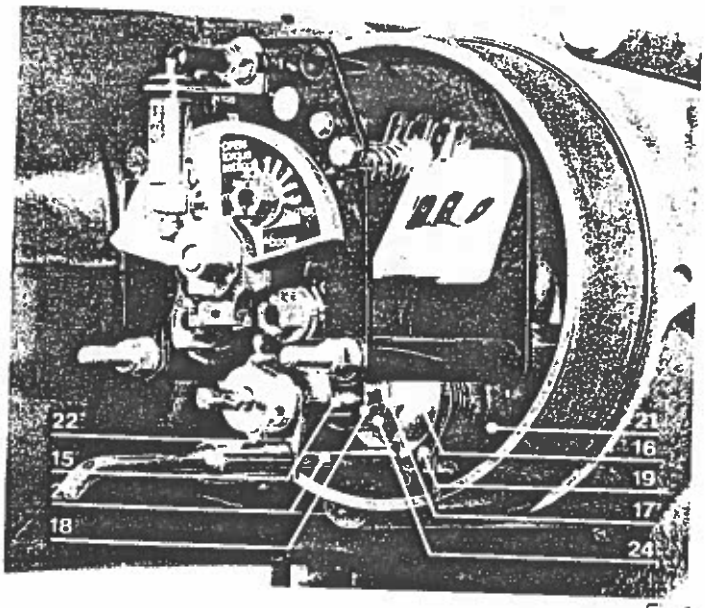


Fig 1

Mount your actuator on the valve, see section 3. Remove the switch mechanism cover as follows:

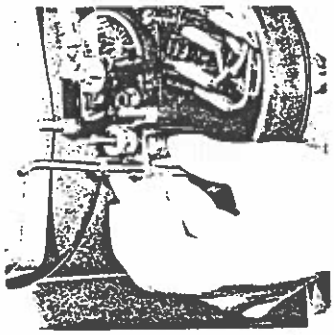
Remove the three retaining screws adjacent to gear case using a 5/32" AF Allen key. (5mm if cenelec enclosure.)

Pull off cover squarely with both hands. Do not attempt to lever cover off with a screwdriver. This is likely to damage the 'O' ring and may also damage the flame path on a certified unit.

Engage handwheel drive. (see section 1.)

See Fig. 1. Break open locknuts 17 and 18 and run both back to outboard end of screwed shaft 15. Leave loose. Loosen clutchnut 22 by turning anticlockwise at least three full turns.

Note that the screwed shaft can now be turned with the fingers. As you turn it note that travelling nut 16 moves up and down the shaft.



Turn actuator handwheel until valve is closed as far as *mechanically possible*.

Turn screwed shaft 15 anticlockwise with your fingers until you feel the travelling nut comes hard up against its backstop 19.

Gripping screwed shaft between thumb and first finger you will be able to continue to turn it, by using the overtravel guide 20 for leverage. Continue to turn until overtravel guide comes up against overrun stop 21.

During this final movement you will have heard the switches click.

Holding overtravel guide hard over against its stop, tighten clutchnut.

After fully tightening clutchnut, you can release your pressure on the overtravel guide. Apart from nominal backlash on releasing pressure, the overtravel guide should not move away from stop and the switches should not be heard to reset. If you hear a 'click' at this stage you have not carried out the preceding instructions correctly.

The 'close' switches are now set so that they trip just before the mechanical stop is reached. For valves with limit functions on closing, check shut position by operating electrically. If valve does not fully shut, handwind to mechanical stop, loosen clutchnut 22 and allow overtravel guide 20 to return to neutral position. Turn screwed shaft 15 anticlockwise, with the aid of overtravel guide, to just beyond position where all switches are heard to operate but before overtravel guide hits stop 21. Tighten clutchnut and ensure switches do not reset when guide is released.

Now wind the valve open as far as mechanically possible. *Do not then wind it back a fraction 'for safety's sake'.*

Using one finger, pull overtravel guide (20) over clockwise, until it comes hard up against its stop (21). Keep it hard over in this position. Switches will have been heard to click during this operation.

With overtravel guide still held hard over, run locknut 17 clockwise down screwed shaft until it comes up hard against travelling nut.

Push washer 24 down screwed shaft until it is against locknut 17 then run locknut 18 down until it clamps both locknuts and washer together. **Lightly** tighten locknut 18.

Release pressure on overtravel guide. Overtravel guide should stay put against stop and switches should not be heard to reset. If a 'click' is heard after releasing the pressure on the overtravel guide you have not carried out the preceding instructions correctly.

The 'open' switches are now set. By following the procedure exactly you have ensured:

1 That the switches are set to cut off the motor before the valve reaches its end of travel and that the motor has time to come to rest.

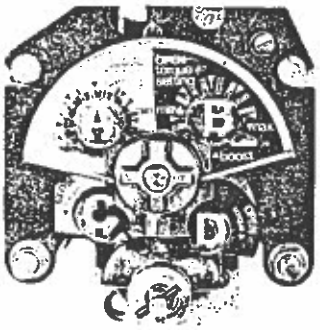
2 That manual operation of the valve can never alter the switch operating point which you have set.

5.1.3 Selecting torque or limit control

Check if the correct torque or limit functions have already been selected as follows:

With the switch mechanism cover still removed check the positon of the 'open' and 'close' torque/limit selectors. They should tally with

the torque or limit positions on the table below, or with your valvemaker's specific instructions.



If necessary, dial selectors C and D to suit your particular valve.

Select the correct torque or limit functions for your valve as follows:

If you have bought a complete motorized valve, your valvemaker will probably have made the correct torque or limit selection to suit his own valve.

In the absence of specific valvemaker's instructions, use the following basic table:

Valve type	'close'	'open'
Wedge gate or globe	'torque'	'limit'
Butterfly, thru conduit ball, plug, sluice gate or parallel slide	'limit'	'limit'

5.1.4 How to select torque values

Selectors A and B adjust the amount of torque which can be applied to the valve before the torque switch cuts out the motor.

Ideally, only the minimum torque necessary to achieve tight shut-off should be applied. In practice this value will vary from valve to valve and fluctuate with temperature, use, service etc.

We recommend that you dial selector A which contorls closing torque to the first marked calibration from the MIN position. But be prepared to remove the switch mechanism cover after start-up to increase the torque value if tight shut-off is not being achieved with your original setting.

Selector B which controls opening torque should be dialled to MAX unless the valvemaker's specific instructions recommentd against this.

Torque seting adjusters are fitted with locking tabs to discourage unauthorised tampering with original settings. After adjusting 'open' and 'close' torque to require value, lock setting by bending up appropriate tabs each side of pointer. If no open torque limit is required, turn open torque adjuster pointerto boost position, where no locking is required.

5.1.5 How to replace switch mechanism cover

Ensure that indicator lamp support, if fitted is central. Ensure that O-ring is in good condition (spare may be found in terminal box).

Offer cover up squarely to spigot, register and push on. Tighten the three securing screws.

5.2 Optional extras

5.2.1 Setting intermediate auxiliary switches (AOP1 only)

Note: Add-on-Pak 1 setting is entirely independent of the switch mechanism.

For Add-on-Pak 1 to be supplied fitted to the actuator, the number of turns must have been specified at the time of ordering and its gear ratio should therefore be correct.

Add-on-Pak 1 incorporates a scale adjusting mechanism to align the pointer movement with scale length. This may have been preset to suit the valve. Both of the above may be checked by hand operating the valve full stroke; the pointer should move continuously from 'shut' to 'open'. If it does not, the scale adjuster setting or the gear ratio may be incorrect, see publication AE5/4.8 in Maintenance and Spare Parts manual.

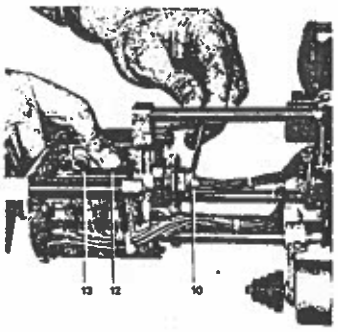
If it operates correctly, you have only set the switches to trip at the required valve positions.

Note: Instructions are for 'clockwise closing'. For 'anti-clockwise' read 'opening' as 'closing' etc.

From a suitable mid-travel position operate valve to the point at which switches are required to trip in closing direction.

Loosen nut 10 at rear of cam shaft. Set inner cam 12 so that it just trips switches IAS4, 5 and 6. Partially tighten nut.

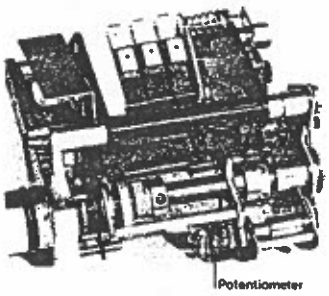
Operate the valve to the point at which switches are required to trip in opening direction.



Loosen nut 10 again, set outer cam 13 to trip switches IAS1, 2 and 3. Tighten nut fully.

5.2.2 Setting the potentiometer

For potentiometer drives fitted to the switch mechanism only:



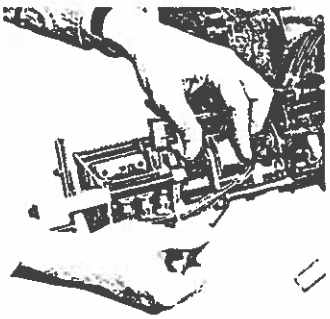
Loosen drive screws fixing gear drive coupling. Close valve.

Rotate gear drive coupling anticlockwise (viewed from front of switch mechanism) until firm stop is felt. Tighten drive screws.

For potentiometer drives fitted to AOP1 (valve should be fully open):

Normally the correct potentiometer gear will be meshed with the main potentiometer drive gear to suit the number of actuator output turns specified for full valve travel.* Having noted which gear has been selected, unclamp the potentiometer assembly from its mounting pillar using a $^{3}/_{32}$" AF Allen key. Unmesh the potentiometer gear and rotate the potentiometer spindle anti-clockwise so that it is about 2° away from the end of its travel.

*See publication AE5/4.8 for correct selection if necessary.



Mesh with the correct gear and clamp.

5.2.3 Setting Current Position Transmitter (CPT)

The CPT gives continuous indication with adjustment for span and zero settings and can be either internally or externally powered. For a CPT with PCB mounted in the switch mechanism compartment please refer to paragraph 5.8.2 for settings.

The following settings are for the CPT mounted behind the pushbutton cover as shown on fig. A overleaf.

1 Signal direction

a Check whether valve is clockwise or anti-clockwise to close.

b Using fig. A overleaf locate the dual links J7. For clockwise to close valve with low signal at closed, also for anti-clockwise close with low signal at open, link J7 must be positioned parallel to the edge of the PCB.

c For clockwise to close valves with low signal at open, and for anti-clockwise to close with low signal at closed, link J7 must be positioned at right angles to the edge of the PCB.

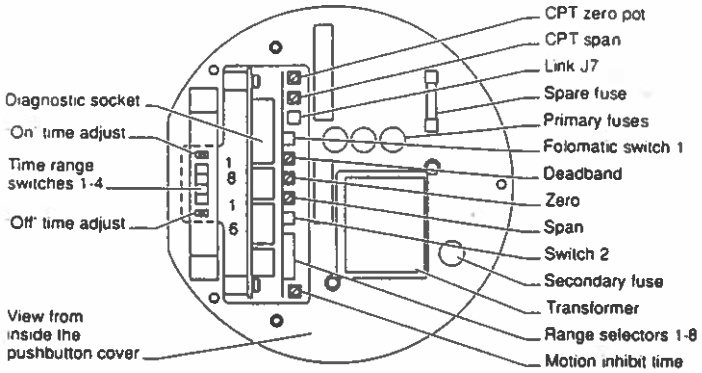


Fig. A

2 Settings

a Move valve to the low signal end of travel.

b Adjust the CPT zero trimmer potentiometer to the required minimum signal.

c Move valve to the high signal end of travel.

d Adjust the CPT span trimmer potentiometer to the required maximum signal.

e Move the valve back to the low signal end of travel and recheck the low reading and adjust if necessary.

The following instructions are for a CPT with PCB mounted in the switch mechanism compartment (see fig. B).

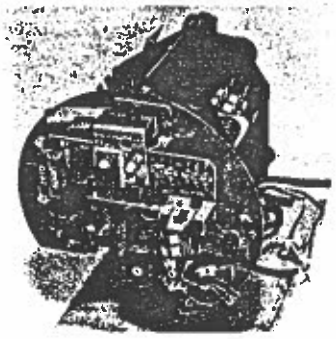


Fig. B

a First set actuator torque and limit switches as above, run the actuator to the fully closed position.

b Set the mechanical zero of the potentiometer transmitter, checking that the correct gears are selected to suit full travel.

c Check that the remote connections to the CPT are suitable for internally or externally powered systems as applicable. (See actuator wiring diagram).

d With the valve closed, set minimum required signal by adjusting zero potentiometer on CPT PCB.

e Operate valve to fully open position and adjust span control to give required maximum signal. For maximum signal indication corresponding to valve closed position, isolate DC supply, interchange outer connections on potentiometer, re-engage potentiometer drive gear so that it is fully clockwise with the valve fully open and then repeat zero and span adjustments as above with DC supply re-connected.

5.2.4 Blinker

The blinker is factory set to suit the actuator output turns range and no further setting is normally required.

5.2.5 Folomatic proportional control

Zero/Span/Timer/Deadband
The Folomatic Proportional Control module sets the valve position relating to an input signal with adjustments for Zero and Span setting. Refer to the wiring diagram supplied in the actuator and also the customers instructions for exact setting.

When the actuator Local/Off/Remote selector is set to 'Local' the actuator functions like any other with Open/Stop/Close local control. The actuator should therefore be set to work initially under local control in accordance with this instruction book.

Setting the integral type Folomatic
The following instructions are for actuators with Folomatic settings behind the pushbutton cover (see fig. A).

1 Determine whether the valve is clockwise or anti-clockwise to close and also whether it is to open on a low demand signal.

Using fig. A locate switches 1 and 2. select as follows:

a For clockwise closing valves
Input signal low to close, SW1 selected towards edge of board, SW2 selected away from edge of board.

Input signal low to open. SW1 selected away from edge of board. SW2 selected towards edge of board.

b For anti-clockwise closing valves
Input signal low to close. SW1 and SW2 away from edge of board.

Input signal low to open. SW1 and SW2 towards edge of board.

2 Determine what control input signal is going to be used, refer to Appendix 1, page 18 and locate the block of DIL switches and select range required.

Note: If the range required was indicated at the time of ordering the correct range will be set. If not then the Folomatic will be set for 4 - 20mA.

3 When using a 4-20mA control loop signal it is possible to select whether the actuator will 'stay put' or fail to the 4mA end of travel on loss of signal. Switch No. 1 on Folomatic DIL switches to be selected 'on'.

Switches 2.3 and 2.4 on main board DIL switches
Both selected 'on' gives fail to the close end travel.
Both selected 'off' gives fail to the open end of travel.
One switch 'off' and one 'on' will give 'stayput'.

4 Check that incoming control cables are connected to the following

a Current or voltage signal to 13(-ve) and 22(+ve). or alternatively.

b Customers potentiometer derived signal to 13, 22 wiper and 31.

5 With actuator set to local control run the valve to the nominated low signal end of travel.

6 Set input to required minimum value.

7 Locate the'Zero' trimmer and adjust until the green indicator (if valve is at closed position) or red indicator (if valve is at open position) on the PCB just lights either flashing or steady, clockwise movement of zero trimmer will illuminate the appropriate indicator.

8 Operate the valve to the opposite end of travel (high signal) using local control.

9 Set input signal to its required maximum level.

10 Locate the 'Span' trimmer and adjust until the red indicator (if valve is at the open position) or green indicator (if valve is at the closed positon) on the PCB just lights, either flashing or steady. Anticlockwise movement of the span trimmer will illuminate the appropriate indicator.

11 Set Local/Remote selector to 'Remote'. The actuator is available for Folomatic remote control to give full valve stroke with maximum input signal.

12 Deadband adjustment
If the actuator overshoots or responds unnecessarily to smal changes in signal, increase the deadband by turning the deadband control clockwise. If greater sensitivity is required reduce deadband by turning anticlockwise. Check that huntir does not occur eg. when the actuator is moving in the increasing signal directon. it should stop when the balance between the input signal and th actuator feedback potentiomete is achieved without the green light flashing after the red lamp has extinguished. If hunting do occur, increase the deadband a necessary.

Motion inhibit timer adjustment
The red and green indicators o the PCB indicate a change of signal state:

Red = in the open position
Green = in the close position

If either indicator is flashing it indicates a change of signal st that is being prevented from operating the actuator for a predetermined length of time. This motion inhibit time is

adjustable between 2 seconds and 40 seconds to suit site conditions. However it is advisable to reduce the delay time (anticlockwise adjustment of the trimmer) to minimum during the setting up procedure.

Setting the deep cover type Folomatic

The following instructions are for actuators with the Folomatic control unit fitted in a deep cover mounted on the terminal box.

When the Syncropak local/off/remote switch is set to 'local', the actuator functions like any other with open/stop/close manual control. The actuator should therefore be set to work initially under manual control in accordance with these instructions, the open and close torque and limit switches being set to suit the valve requirements. Only a 3-phase supply is required for this.

Electrical connections - 1400 Series only

For deep cover version fitted to 1600 Series apply to Rotork if alternative control mode is required.

1 Check whether valve is clockwise or anti-clockwise to close.

2 Determine whether valve is to close or open with low demand signal.

3 For clockwise to close valves, closing on low demand signal and anti-clockwise to close valves opening on low demand signal, the electrical connections between the Folomatic unit of the actuator terminals should be as follows:

Wire 37 38 39 14 23 32 4 5
Terminal 37 38 39 14 23 32 4 5

4 For clockwise to close valves opening on low demand signal and anti-clockwise to close valves closing on low demand signal, the electrical connections are as follows:

Wire 37 38 39 14 23 32 4 5
Terminal 38 37 39 32 23 14 4 5

Check that the correct shunt and series range resistors are fitted as follows:

Current range

	Series range resistor	Shunt range resistor
0- 5mA	500mA fuse link	1000
0-10mA	500mA fuse link	500
0-20mA	500mA fuse link	250
0-50mA	500mA fuse link	100

Voltage range

0-5V	100mA fuse link	5K
0-10V	5K	5K
0-20V	15K	5K
0-50V	45K	5K

Potentiometer (0.5K - 10K)

100mA fuse link	Open circuit

Setting Folomatic control unit

With the actuator and three phase supply of the correct voltage and rotation already wired but isolated, the procedure for setting the Folomatic Control unit is as follows:

1 Move valve to low signal end of travel.

2 Remove actuator indicator cover and set feedback potentiometer to the end of travel by rotating the cone of gears. Engage the appropriate gear in accordance with this instruction book.

3 Set 'local/off/remote' switch to 'local'.

4 Remove the Folomatic control unit using cover screws in jacking holes provided in accordance with this instruction book and lower carefully until supported by restraining strap. The unit can be temporarily bolted at one corner while the analog signal wires are connected as follows: current or voltage signal to F1- and F2+, potentiometer signal F1, F2 (wiper) and F3.

5 If the actuator is required to stay-put on loss of analog signal, link terminals F4 and F5.

6 Set input signal to required minimum valve.

7 Switch on three phase power supply. Adjust zero control potentiometer until green indicator just lights, either flashing or steady. Clockwise movement of zero control should turn on green and anti-clockwise red indicator.

Red signal indicator illuminates when there is an amplifier output to trigger movement in the direction corresponding to increasing signal.

Green signal indicator illuminates when there is an amplifier output to trigger movement in the direction corresponding to decreasing signal.

8 Operate valve to high signal end of travel using local control.

9 Increase input signal to maximum. Adjust span control potentiometer until red indicator just lights, either flashing or steady. Anti-clockwise movement of span control should turn on red, and clockwise green indicator.

10 Set 'local/off/remote' switch to 'remote'. The actuator is now set to give full valve stroke with maximum input signal span.

11 Deadband adjustment
If the actuator overshoots or responds unecessarily to small changes in signal increase the deadband by turning deadband control clockwise. If greater sensitivity is required reduce deadband by turning anti-clockwise. Check that hunting does not occur, eg. when the actuator is moving in the increasing signal direction, it should stop when the balance between the input signal and the actuator feedback potentiometer is achieved without the green light flashing on after the red lamp has extinguished. If hunting does occur increase the deadband as necessary.

12 Motion inhibit adjustment*
The inhibit time can be minimised for setting purposes by adjusting motion inhibit time control anti-clockwise. The time should however be increased to the maximum, which will permit adequate control response in operation to give optimum service life and performance as soon as commissioning is complete.

13 Check that cable glands are tight and any unused entry sealed with threaded metal plug and sealing tape. If possible pour sealing compound into conduit entries from inside terminal compartment to perfect weather seal.

14 Replace Folomatic control unit and indicator cover with 'O' rings in place and screws tightened fully.

* Zero, span, deadband and motion inhibit controls are potentiometers with 27 turns for full travel incorporating a slipping clutch at each end of travel.

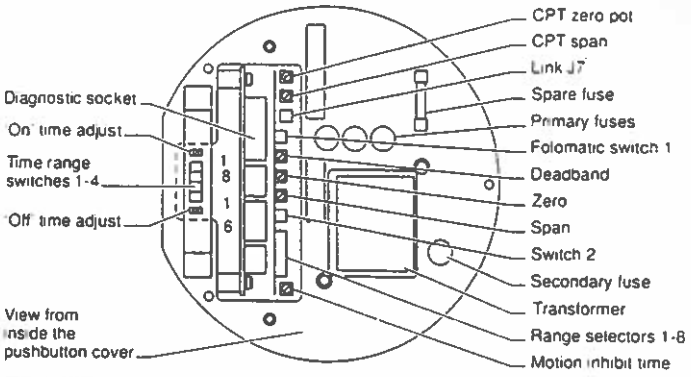


Fig. A

5.2.6 Interrupter timer

When fitted, this can be used to lengthen the valve travel time in either one or both directions. It can also be used in conjunction with Add-on-Pak 1 intermediate limit switches to slow down the last portion of travel.

Setting instructions
A pair of potentiometers will be found behind the pushbutton cover. See fig. A. They are marked 'on' and 'off' and are used to set the on/off times of operation.

After removing the cover, rotate the potentiometers fully anti-clockwise. This will give the shortest 'on' and 'off' times. Rotating either potentiometer clockwise will increase the time (on or off) and a convenient interrupting sequence can be set so that there are no unnecessary frequent starts demanded from the actuator. Where the actuator is to be used in '2-speed' mode, the appropriate Add-on-Pak 1 switch will need to be set to break at the start of the interruption sequence. See section 5.2.1 and wiring diagram.

5.2.7 'PA' failsafe actuators

(Refer to Rotork publication AE5/8 for coupling details).

6 Electrical start-up

Check that limit switches have been set: see section 5.

All actuators (except Syncropak 1600 series)

6.1 Checking rotation

If valve stem is not visible, remove stem cover to observe direction of output rotation.

Engage 'hand' and wind handwheel until valve is well away from end position.

6.2 Syncropak 1400 series actuators

Switch on power supply and check that indicator lamp is on.

Remove padlock (if fitted) and turn selector switch to 'local'.

Turn pushbutton to 'open' and check output rotation.

If phase rotation is correct valve should open. If valve starts closing press pushbutton immediately to stop actuator and avoid valve damage or jamming.

If your actuator has been fitted with a Rotork Phase Rotation Discriminator to avoid such accidental damage, it will not start with incorrect phase rotation or with one phase dead.

Correct phase rotation as follows:

3 phase actuators
Exchange any two of three phase supply leads at power terminals; see section 4.

Single phase actuators
Exchange connections to terminals 2 and 3.

If valve runs open, run valve to full travel in 'open' and 'close' directions.

If actuator stops prematurely it may be due to too low a torque setting. Increase as necessary; see section 5.

For valve requiring precisely controlled position limit, check that valve maker's mark on valve is reached. If it is not this is due to incorrectly set limit switches; see section 5.

Replace stem cover using suitable sealing tape or compound and return selector switch to appropriate position. Padlock if required.

6.3 Syncropak 1600 Series actuators

Syncropak 1600 Series incorporates automatic phase rotation correction by Syncrophase.™

This circuit corrects motor rotation, by selecting the appropriate motor contactor irrespective of customer's supply phase rotation.

6.4 Syncroset actuators

Switch on power supply. If there are no pushbuttons within sight of the actuator arrange telephone link between control station and the observer at the actuator.

Press 'open' button.

If connections are correct valve should open.

If the valve starts closing stop immediately. If there is no local stop, engage hand immediately and hold in hand drive until remote stop button is operated.

Correct phase rotation as follows:
3 phase actuators
Exchange any two of three phase supply leads at power terminals.

DC actuators
Exchange connections at terminals 1 and 2.

Single phase actuators
Exchange connections at power terminals 2 and 3.

6.4.1 If valve opens, run valve to full travel in 'open' and 'close' directions.

If the actuator stops prematurely is may be due to too low a torque setting. Increase as necessary; see section 5.

For valves requiring precisely controlled position limit, check that valve marker's mark on valve is reached. If it is not, this is due to incorrectly set limit switches; see section 5.

Replace stem cover using suitable sealing tape or compound.

7 Trouble shooting

7.1 Syncropak actuators

The starter cover is bonded by the Rotork quality control seal, and should only be removed if electrical tests made at the terminal box indicate an internal fault.

Check that the clutch lever is not padlocked in hand before trouble shooting unless you wish to run the motor without driving the valve.

Actuator fails to start on remote control

The packaged controls of Rotork Syncropak make fault location simple.

Set selector switch to local and switch on power supply, when the indicator lamp should light. If the actuator starts correctly in each direction when the pushbutton is turned, *the fault can only be in the remote control circuit.*

Actuator fails to start on local control

Set selector switch to local and switch power on. If actuator fails to start remove terminal cover and check, if 3 phase, that all three phase terminals are live, with the correct voltage as indicated on the nameplate and that 110 - 120 volts is available at terminals 4 and 5 (1400 series) or 24V (1600 series).

If the motor is very hot, thermostat will have tripped, which will disconnect control supply between terminals 40 and 4. If there is no voltage between terminals 4 and 5, you may break quality control seal and remove starter cover. Check transformer fuses and replace if necessary with spare provided.

Note: 1400 series only: The diagram number on wiring code card inside cover will indicate if Phase Rotation Discriminator is fitted, in which case actuator will not start with incorrect rotation. Exchange any two phases and try again.

7.2 Syncroset actuators

Check that clutch lever is not padlocked in hand before trouble shooting unless you wish to run motor without driving valve.

Actuator fails to start

Remove terminal cover and check that all three phase terminals are live with the correct voltage indicated on the nameplate, when the pushbuttons are operated with the power on. If motor is very hot, thermostat will have tripped, to produce an open circuit between terminals 33 and 34.

7.3 All actuators

Valve jammed
Likely causes:

1 Reversed phase rotation/ incorrect rotation. (Not applicable to Syncropak 1600 Series). See section 6.

2 Limit switches not set correctly; see section 5.

To free valve jammed open
Manual operation of the handwheel utilizing the hammerblow mechanism should be sufficient to unjam the valve.

To free valve jammed shut
Loosen actuator mounting bolts evenly to release thrust. Free the valve by hand and re-tighten mounting bolts.

Valve not seating correctly
Likely causes:

1 The 'close' torque/limit selector has been set at 'limit'. Re-set to 'torque'.

2 The 'close' torque setting is too low. Increase as necessary; see section 5.

Actuator runs without driving valve
Likely causes:

1 Clutch lever padlocked in 'hand'.

2 Drive bush not correctly locked in place; see section 2.

8 Lubrication and maintenance

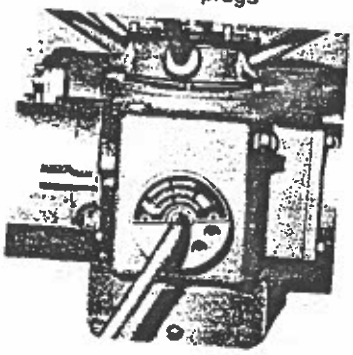
8.1 Oil

Unless specially ordered for extreme climatic conditions, Rotork actuators are despatched with gearboxes filled with SAE 80 EP oil, suitable for ambient temperatures ranging from -22°F/-30°C to 160°F/70°C.

Oil capacities

7A, 11A, 13A: 0.6 litre
14A, 16A: 1.4 litre
30A: 2.0 litre
40A: 3.0 litre
70A, 90A, 91AR, 95A: 4.5 litre

8.2 Oil fill/drain plugs



◯ Oil fill/drain plugs

The use of the plugs provided is determine by the mounting position on the valve.

8.3 Maintenance

After six month's operation tighten mounting bolts.

If your Rotork actuator has been properly installed and sealed, normal valve operation produces little wear and tear, so no routine maintenance is recommended beyond the lubrication of valve stems and nuts. If the motorized valve is rarely operated, a routine operating schedule should be set up.

Appendix 1

Folomatic PCB DIL switch settings voltage or current ranges

Range	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8
0-5mA	○	○	○	●	○	○	○	○
0-10mA	○	○	○	●	○	○	●	○
0-20mA	○	○	○	●	○	●	●	○
4-20mA	◑	○	○	●	○	●	●	○
0-50mA	○	○	○	●	●	●	●	○
0-5V	○	○	○	○	○	○	○	○
0-10V	○	○	●	○	○	○	○	○
0-20V	○	●	○	○	○	○	○	○

○ Off

● On

◑ Off/On

SW1 Off - actuator runs to low signal end of travel on loss of signal.

SW1 On - actuator responds on loss of signal accord. To priority setting on main PCB switches 3 and 4 on 'AQ' (or 6 and 7 on'Q' range).

Major service centres

If your Rotork actuator has been correctly installed and sealed, it will give years of trouble-free service.

Should you require technical assistance or spares, Rotork guarantees the best service in the world. Contact your local Rotork representative or the factory direct at the address on the nameplate, quoting the actuator type and serial number.

Rotork Controls Ltd
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telex 44823

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telephone Al Khobar (03) 857 9956
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Rotork Controls (Singapore) Pte Ltd
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Singapore 2678
telephone (65) 4571233
fax (65) 4576011
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Beacon Rotork Controls Ltd
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Madras 600 098
India
telephone (44) 652294
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Rotork Australia Pty Ltd
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Ballarat West
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Rotork Controls Limited Korea Branch
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45-11 Yoido-Dong
Yongdeung po-ku, Seoul
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rotork actuation

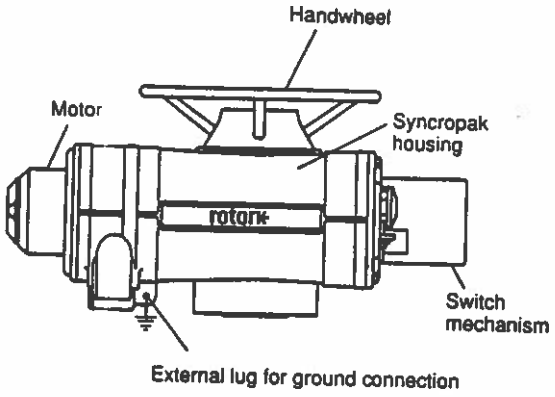
Dimension data for Rotork 'A' Range 14A, 16A and AZ Syncropak actuators

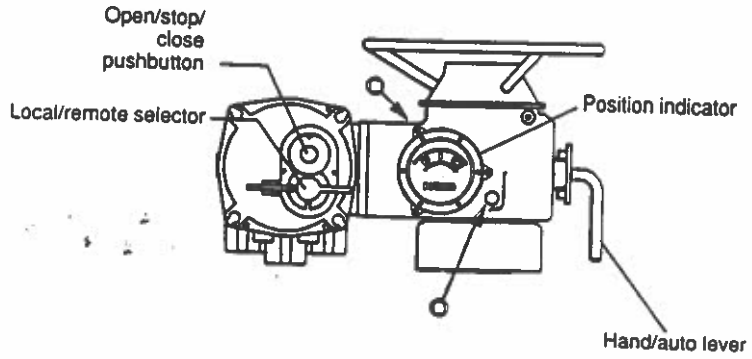
Publication number AE2/1.2
Date of issue 9/91

Shipping specification

Shipping space; basic overall si: without Add-on-Pak 1:

Approximate packed dimensic	s mm *in*			Approximate weight kg *lb*			
length		width		ight		nett	gross
940	*37*	710	*28*	0	*20*	78 *172*	89 *196*





O Oil filler/drain plug

Mounting positions

The actuator will operate satisfactorily in any position. When mounted in an inverted position the end of the stem cover tube should be drilled 4mm ø (⅛") to avoid build up of service fluid or rainwater.

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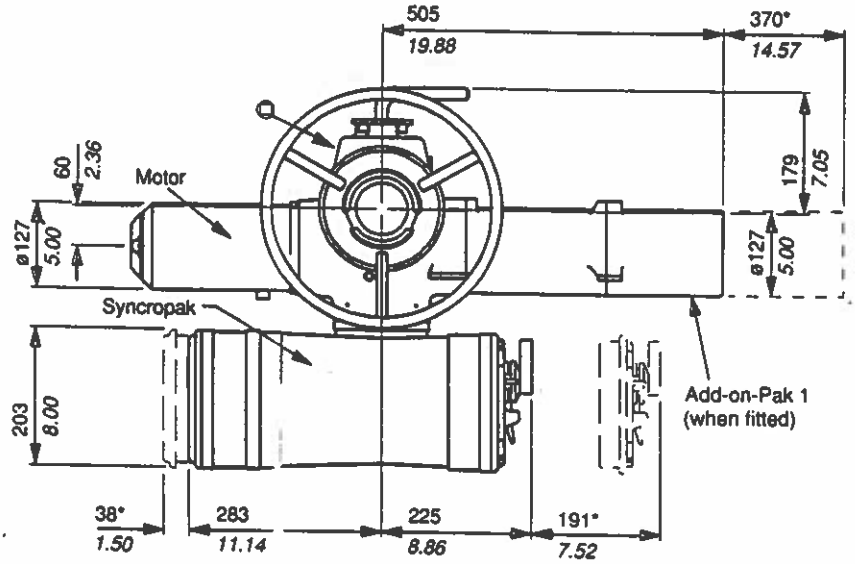
rotork actuation

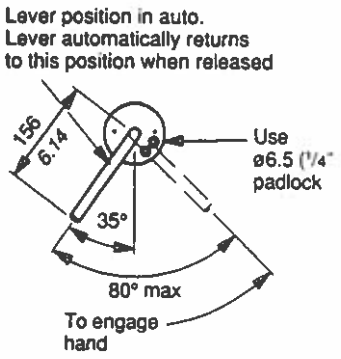
Dimension data for Rotork Syncropak actuators sizes 14, 16A and AZ

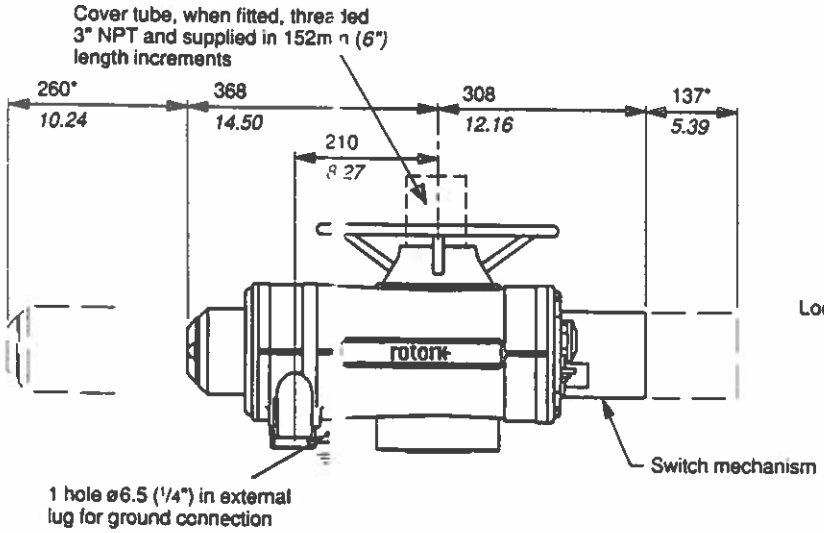
Standard top handwheel arrangement

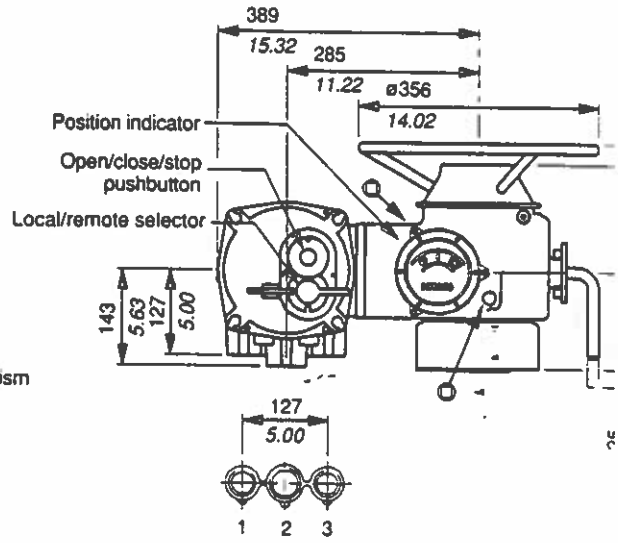
View showing 14A handwheel



Padlockable hand-auto lever







Standard conduit entries

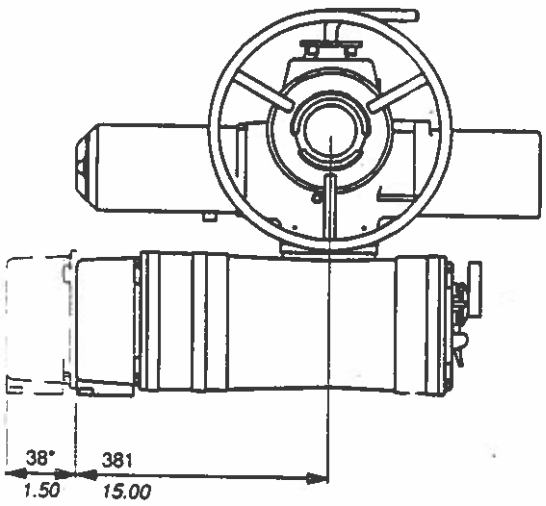
No's 1 and 3 tapped 1 1/4" ASA NPT
No 2 tapped 1 1/2" ASA NPT

Notes

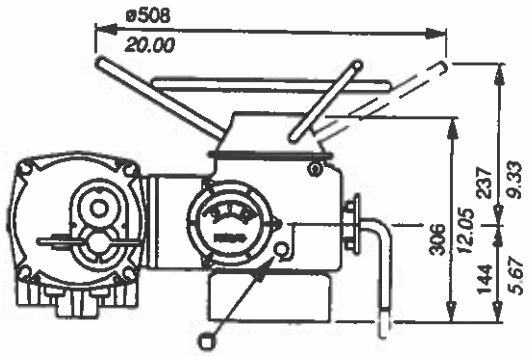
Dimensions with * are cover removal allowance

Oil filler/drain plug

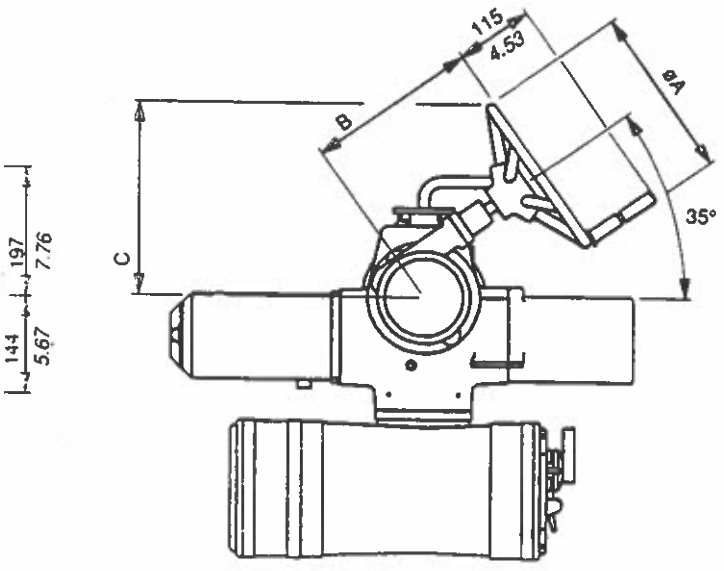
View showing optional deep cover assembly

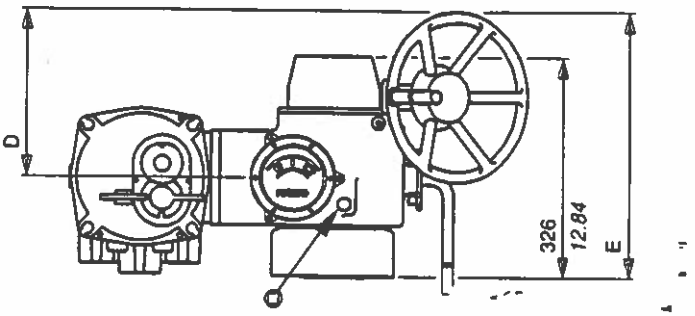


View showing 16A handwheel



14 - 16A optional side handwheel details

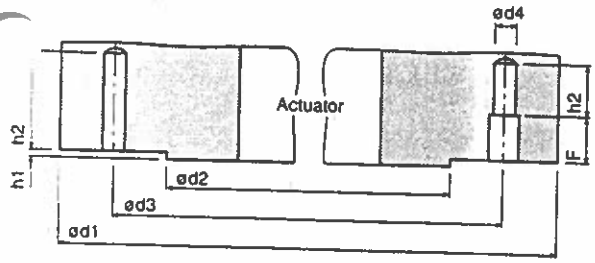




	14A mm	*in*	16A mm	*in*
A	ø254	*10.00*	ø356	*14.00*
B	238	*9.37*	261	*10.26*
C	281	*11.06*	336	*13.23*
D	249	*9.80*	300	*11.81*
E	393	*15.47*	445	*17.52*

Base and coupling dimensions 14A, 16A and AZ

Base dimensions

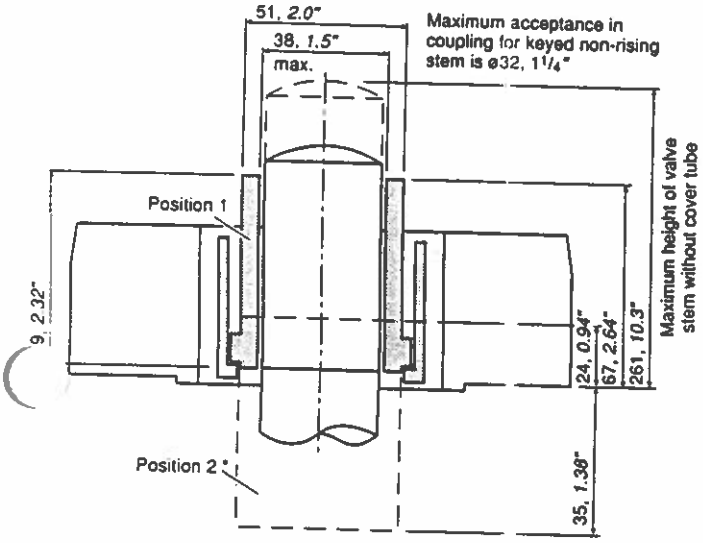


Mounting holes are positioned off centres

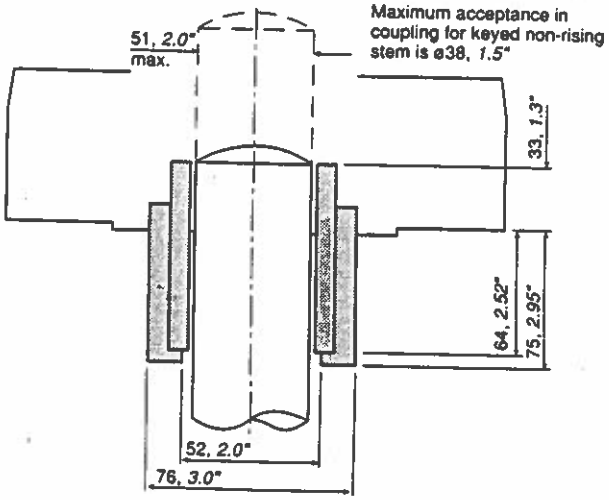
	ISO 5210 base	UNC base
Flange ref.	F14	–
ød1	175	*6.89"*
ød2 (f8)	100	*3.75"*
ød4	M16	5/8" UNC
h1	2.5	*0.094"*
h2	32	*1.25"*
F	-	-
ød3	140	*5.5"*
No. of holes	4	4

Mounting studs/bolts are not supplied by Rotork. Material to have a minimum yield stress of 618N/sq mm (*40 tons/sq in*). Recommended tightening torque = 230Nm (*170lb/ft*).

Coupling type A

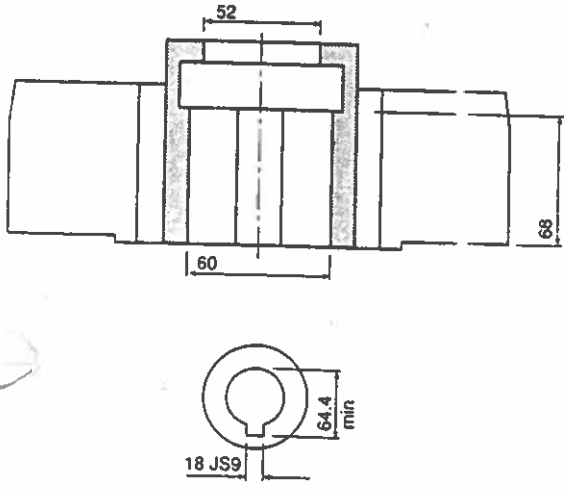


Coupling type AZ

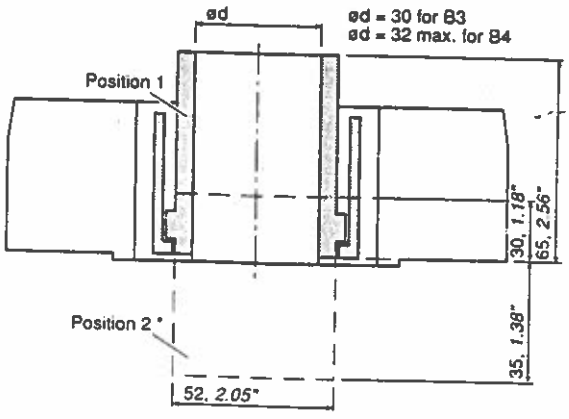


Note: ISO 5210 does not include this type of coupling.

Coupling type B1



Coupling type B3 and B4



* ISO 5210 does not include a coupling in position 2.

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ASAHI/AMERICA

SERIES 92

Installation, Operation and Maintenance Manual

Description

Asahi/America Series 92 reversing electric actuators feature capacitor run motors and permanently lubricated gear train, with hardened steel spur gears. Standard units can provide up to 1100 in-lbs of output torque.

The Series 92 models feature combination Nema-4, 7 enclosures as a standard and are available in 115VAC, 220VAC, 12VDC, 24VDC, 12VAC, 24VAC voltages.

Standard models are equipped with integral thermal overload protection (AC models) with automatic reset, independently adjustable limit switches and declutchable manual override with position indicating beacon, baked powder epoxy coating with stainless steel trim and ISO bolt circle.

Installation

A. To gain access to terminal strip it is necessary to remove manual override knob (Part #18) by loosening slotted set screw (Part #39). Remove 2 cover screws, the remaining 6 cover screws are packaged inside the actuator.

B. Install conduit fitting (1/2" NPT) to actuator base. Note: Proper conduit fitting must be used to maintain enclosure rating (weatherproof, explosion proof or combination weather proof/explosion proof).

C. Make electrical connections to terminal strip as shown on wiring schematic located inside the cover (per various electrical codes there is a green screw on the actuator base plate for grounding purposes). All units are completely calibrated prior to shipment. No internal adjustments should be required.

D. Replace actuator cover, and gasket if removed. Install 8 cap screws supplied and tighten securely. Unit is now ready for operation.

E. Manual Override Operation

Pull up the declutching knob (Part #18) and apply a 5/8" open end wrench to exposed flats and rotate within labeled limits as indicated by arrows.

To re-engage simply rotate actuator shaft until declutching knob drops back down into position.

Setting Limit Switches

Open Travel Limit Switch (Top Switch Part #25) using declutchable manual override, move the valve into a full open position, loosen set screws on top cam (Part #40) and rotate cam into limit switch arm until a click is heard, this designates the switch circuit has opened and defines a full open position. Tighten 2 set screws (Part #40) on cam.

Closed Limit Switch (Bottom Switch Part #25) using declutchable manual override, move the valve to a full closed position, loosen set screws on bottom cam (Part #40) and rotate cam into limit switch arm until a click is heard, this designates the switch circuit has opened and defines a full closed position. Tighten 2 set screws (Part #40) on cam.

Maintenance

The Series 92 are manufactured with factory lubricated grease, in the gear case and gear box. In most cases, this lubricant should never have to be replenished, however if deemed necessary, we recommend using aeroshell grease #17, mfg by Shell Oil Co.

CAUTION: Before any maintenance is performed and to prevent ignition of hazardous atmospheres, and reduce the chance of electrical shock, NEVER remove actuator cover while circuits are live.

Spare Parts

The following should be kept on hand as spare parts.

1 — Limit Switch (Part #25)

1 — Capacitor (Part #27 or #28)

Please specify model and voltage when ordering.

Electrical Requirements

SIZE	TORQUE	115 VAC		220 VAC		12 VDC		24 VDC		12 VAC		24 VAC		CYCLE TIME 90°	WEIGHT
	IN/LBS	AMP DRAW	DUTY CYCLE	AMP DRAW	DUTY CYCLE	AMP DRAW	DUTY CYCLE	AMP DRAW	DUTY CYCLE	AMP DRAW	DUTY CYCLE	AMP DRAW	DUTY CYCLE	(SEC)	(LBS)
392	400	1.2	75%	.6	75%	2.0	75%	4.0	75%	2.0	75%	2.0	75%	10	16
A92	700	1.2	50%	.6	50%	2.0	75%	4.0	75%	2.0	75%	2.0	75%	10	16
B92	1000	1.2	75%	.6	75%	2.0	75%	4.0	75%	2.0	75%	2.0	75%	15	17

Note: All amp ratings are considered locked rotor.

Mounting Instructions

1. Position the valve and the actuator to corresponding positions (either OPEN or CLOSED). The flats on the actuator shaft and the indicator knob should indicate valve position.

2a. Ball Valves: (See Drawing #1263, sizes 1/2"-2")
Install adapter plate #8 to actuator using screws #11. (This step pertains to 1-1/2"-2" 3-way valves only). Mount saddle tight, then tighten set screws #2 to secure in place. Insert coupling #5 on stem of valve and bolt actuator onto assembly tightening bolts #3 evenly.

2b. Ball Valves: (See Drawing #1264, sizes 2-1/2"-4")
Install adapter plate #5 to actuator using screws #7. Mount saddle #4 onto valve; saddle is a tight fit over nick of valve, press down tight, then tighten set screws #2 to secure in place. Insert coupling #6 on stem of valve and bolt actuator onto assembly tightening bolts #3 evenly.

Note: Due to the torque required on sizes 3" and 4", we recommend that saddle #4 be solvent cemented to valve as well as using set screws #7.

2c. Butterfly Valves (up to size 6"): (See Drawing #1265)
A specially machined butterfly valve stem is required to fit with actuator shaft adapter #9. Holes need to be drilled in valve top to accept mounting bracket #2 and bolts #3. Butterfly valve stems are easily removed from manual valves by removing handle or lever and retaining nut. Stem will slide out by pulling upwards on stem. Re-install machined stem and stem retaining nut.

Since butterfly valve disc is trunnion mounted in valve seat, it will not tilt nor tip over if stem is pulled out of valve.

Caution: If valve is in line, do not remove stem until system is shut down and there is no line pressure.

Insert actuator shaft adapter #9 into actuator. Mount bracket #2 to actuator with bolts #7 and tighten evenly. Install valve #1 onto mounting bracket and align stem of valve to engage with actuator shaft adapter. Install bolts and nuts #3 through #6 and tighten evenly. Flats on actuator or indicator shaft should indicate valve position (orientation of disc).

2d. Butterfly Valves (sizes 8" and up):
Same concept and procedure is utilized, however, no machining to any valve part is needed. Remove gear operator from valve. Install mounting bracket to actuator, and install coupling on valve stem. Use same bolt holes where gear operator was previously removed to mount actuator bracket to valve. Again, valve position or disc orientation should be shown by flats on actuator shaft or indicator.

3. Operate the mounted unit to see that the valve and actuator interact smoothly.

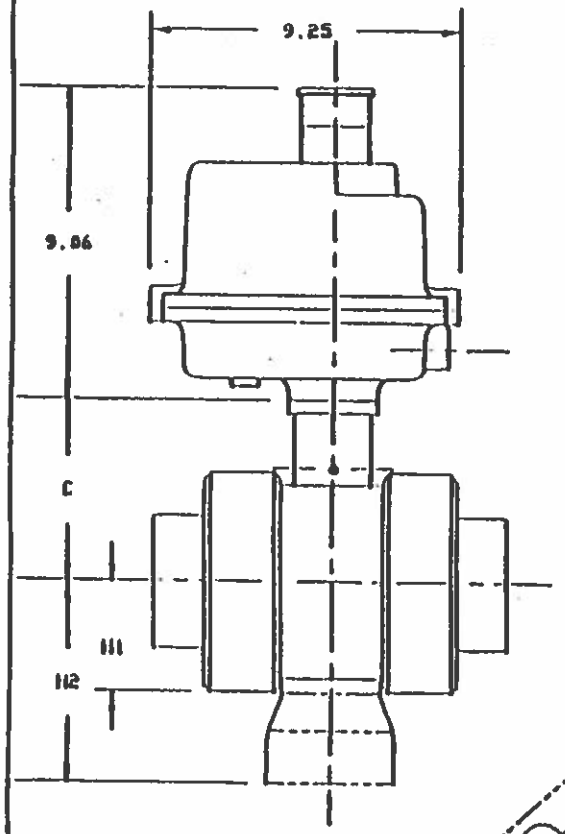
Caution: If mounted unit is installed other than straight up, the actuator should be supported individually in order to prevent sideloading and loosening up of fasteners.

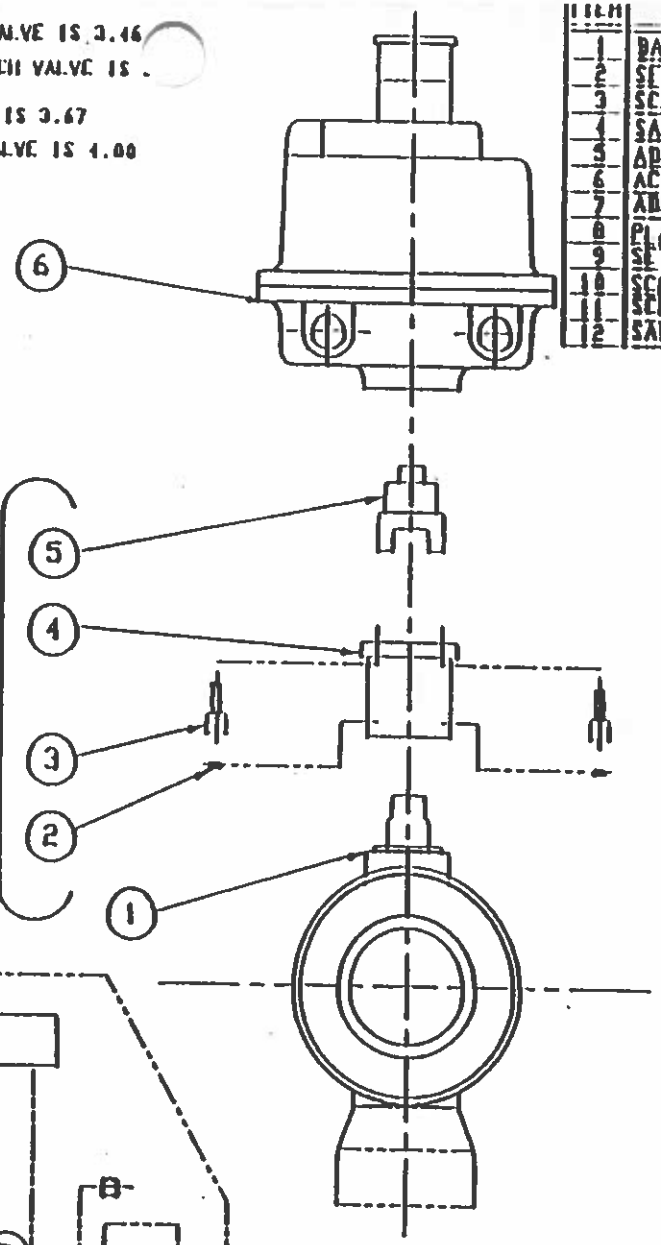
SIZE	H1	H2	C
1/2"	.95	[illegible]7	1.95
3/4"	1.19	[illegible]7	2.31
1"	1.38	2.60	2.46
1 1/4"	1.57	[illegible]	2.92
1 1/2"	1.87	3.06	[illegible]
2"	2.09	4.45	[illegible]2

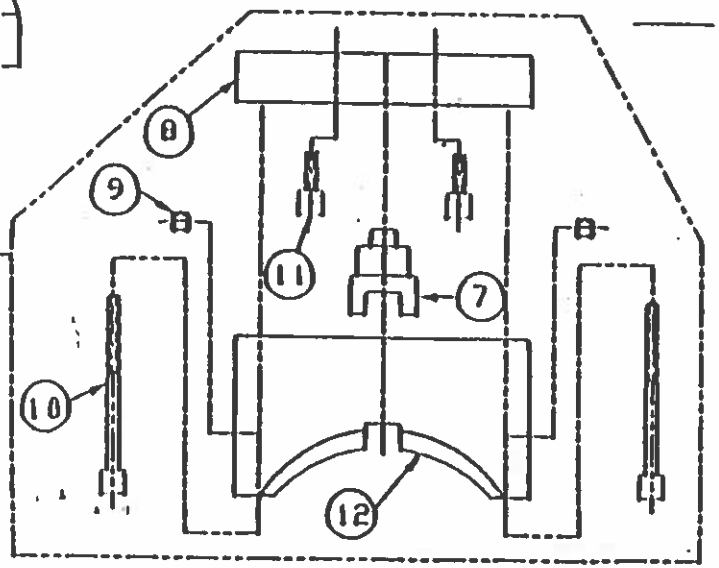
NOTES:

1. DIMENSION C FOR 2 WAY 1 1/2 INCH VALVE IS 3.46
   DIMENSION C FOR MULTIPORT 1 1/2 INCH VALVE IS [illegible]
2. DIMENSION C FOR 2 WAY 2 INCH VALVE IS 3.67
   DIMENSION C FOR MULTIPORT 2 INCH VALVE IS 4.00

ITEM	DESCRIPTION	MATERIAL
1	BALL VALVE (2-3 WAY)	
2	SET SCREW	300 SS
3	SCREW SOC HD	300 SS
4	SADDLE	ANODIZED ALUM.
5	ADAPTOR	ANODIZED ALUM.
6	ACTUATOR	ALUM. EPOXY COATED
7	ADAPTOR	ANODIZED ALUM.
8	PLATE MOUNTING	ANODIZED ALUM.
9	SET SCREW	300 SS
10	SCREW SOC HD	300 SS
11	SCREW SOC HD	300 SS
12	SADDLE MOUNTING	PVC







THIS MOUNTING METHOD IS USED FOR 1-1/2 & 2 INCH MULTIPORT VALVES INSTEAD OF USING ITEMS 2-5

UNLESS OTHERWISE SPECIFIED

SEE PART LIST

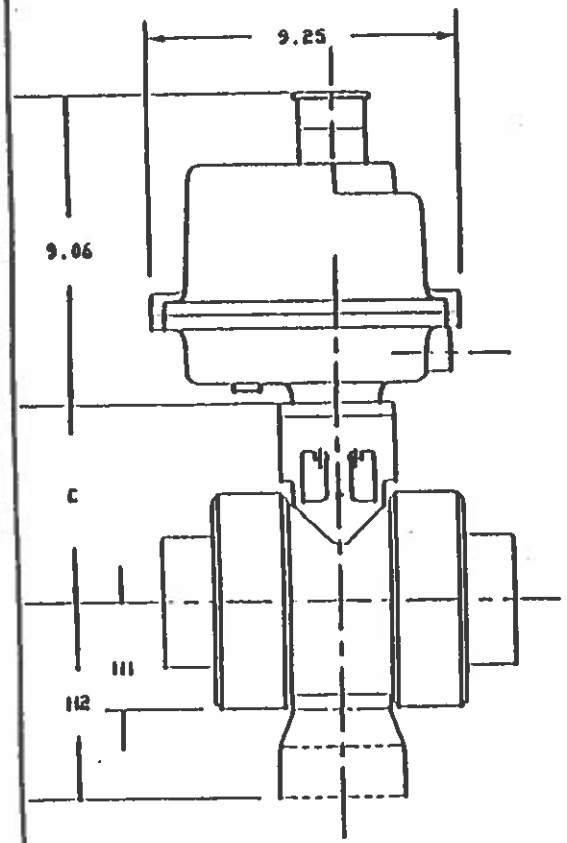
ASAHI/AMERICA

BALL VALVE WITH SERIES 92 ELECTRIC ACTUATOR

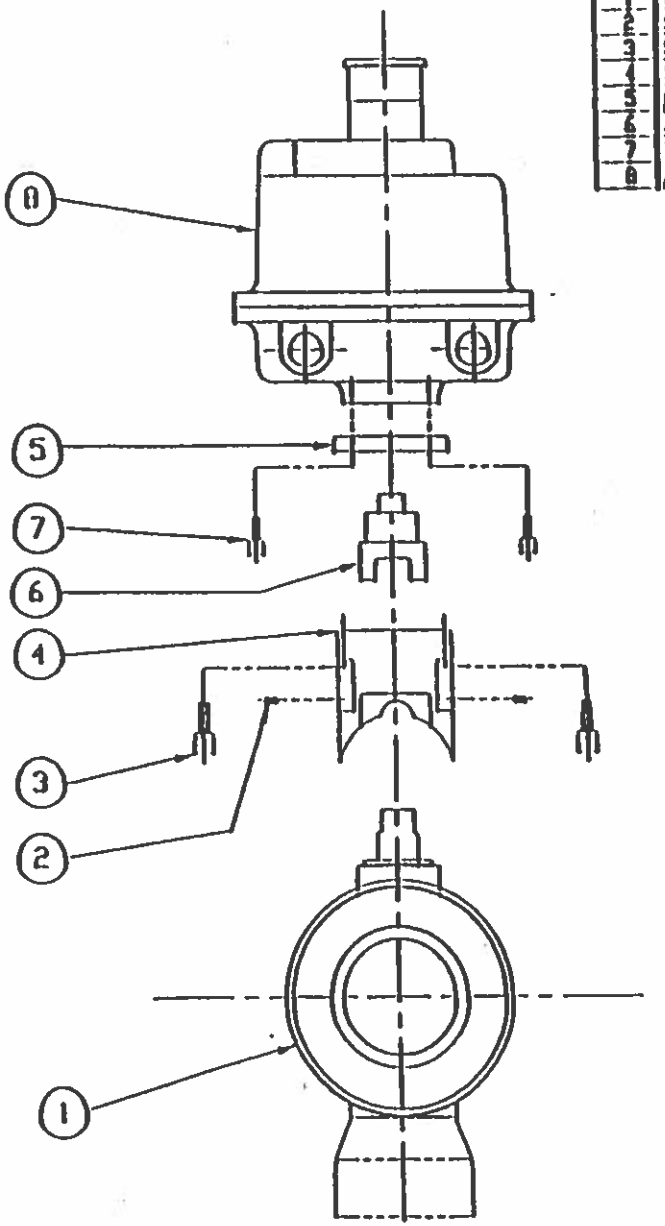
SIZE | CODE NO. 1263 | REV

SCALE NONE | SHEET 1 OF 1

VALVE SIZE	H1	H2	C
2 1/2"	2.62	-	5.12
3"	2.99	6.14	5.59
4"	4.13	7.62	6.88



ITEM	DESCRIPTION	MATERIAL
1	BALL VALVE (2-3 WAY)	
2	SET SCREW	300 SS
3	SCREW SOC HD	300 SS
4	SADDLE	PVC
5	PLATE MOUNTING	ANODIZED ALUM.
6	ADAPTER	ANODIZED ALUM.
7	SCREW SOC HD	300 SS
8	ACTUATOR	ALUM. EPOXY COATED



UNLESS OTHERWISE SPECIFIED
3 PL DECIMALS ±
2 PL DECIMALS ±
ANGLES ±
FRACTIONS ±
MATERIAL
SEE PART LIST
FINISH

THIS DRAWING AND ALL INFORMATION HEREON IS THE PROPERTY OF ASAHI/AMERICA AND SHALL NOT BE REPRODUCED OR COPIED OR USED IN WHOLE OR IN PART AS THE BASIS FOR THE MANUFACTURE OR SALE OF ITEMS WITHOUT WRITTEN PERMISSION.

	NAME	DATE
DR	M. JENSEN	
CHK		
APPD		
MFG		

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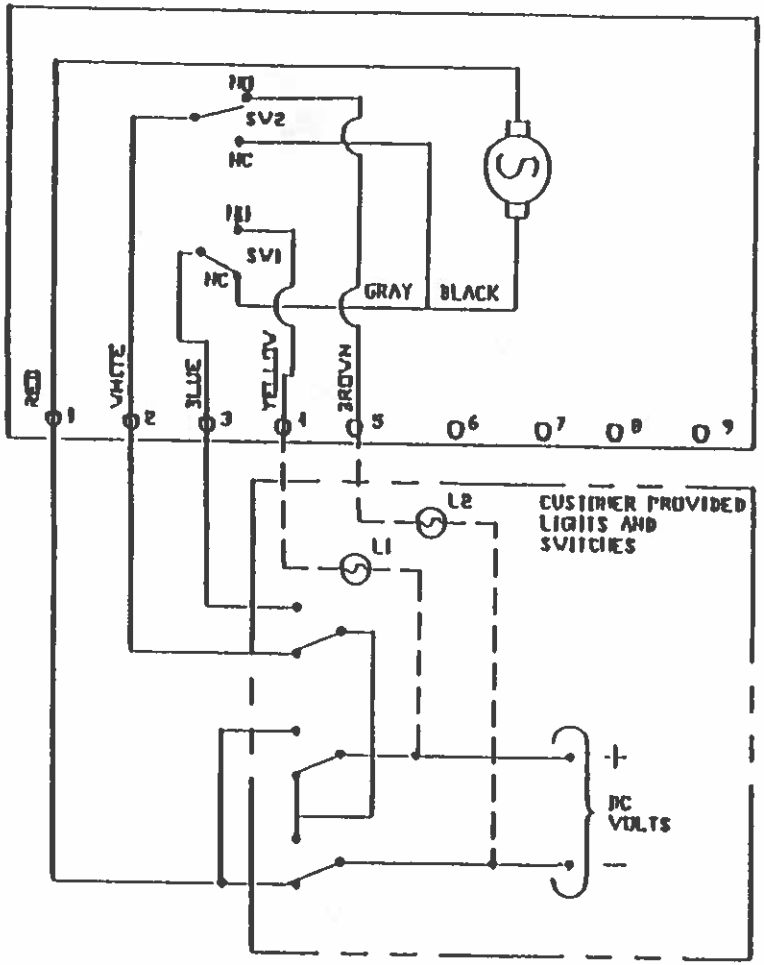
ASAHI/AMERICA

BALL VALVE WITH SERIES 92 ELECTRIC ACTUATO

SIZE | DWG. NO. 1264 | REV

SCALE | WEIGHT | SHEET | OF

DC WIRING DIAGRAM



ACTUATOR SHOWN IN COUNTER CLOCKWISE EXTREME OF TRAVEL OR "OPEN" POSITION

1	2	3	
-	+		= OPEN
+		-	= CLOSE

DRAWING TO BE PRINTED ON 3X6 LABEL

	NAME	DATE
DR	MJ	10/12/93
CHK		
APPD		
FILE	S92	

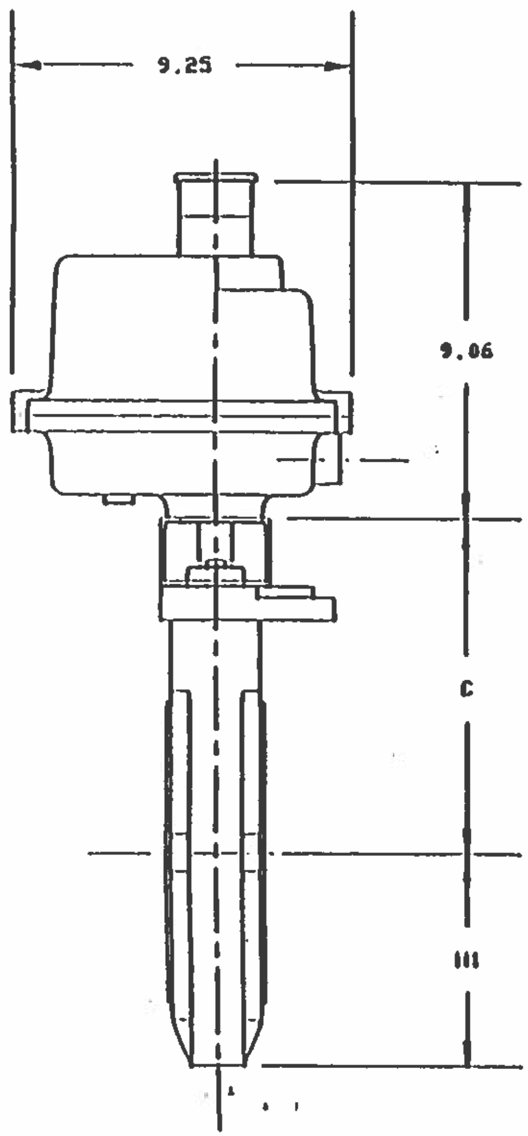
ASAHI/AMERICA
19 GREEN STREET, P.O. BOX 653, MALDEN, MA.

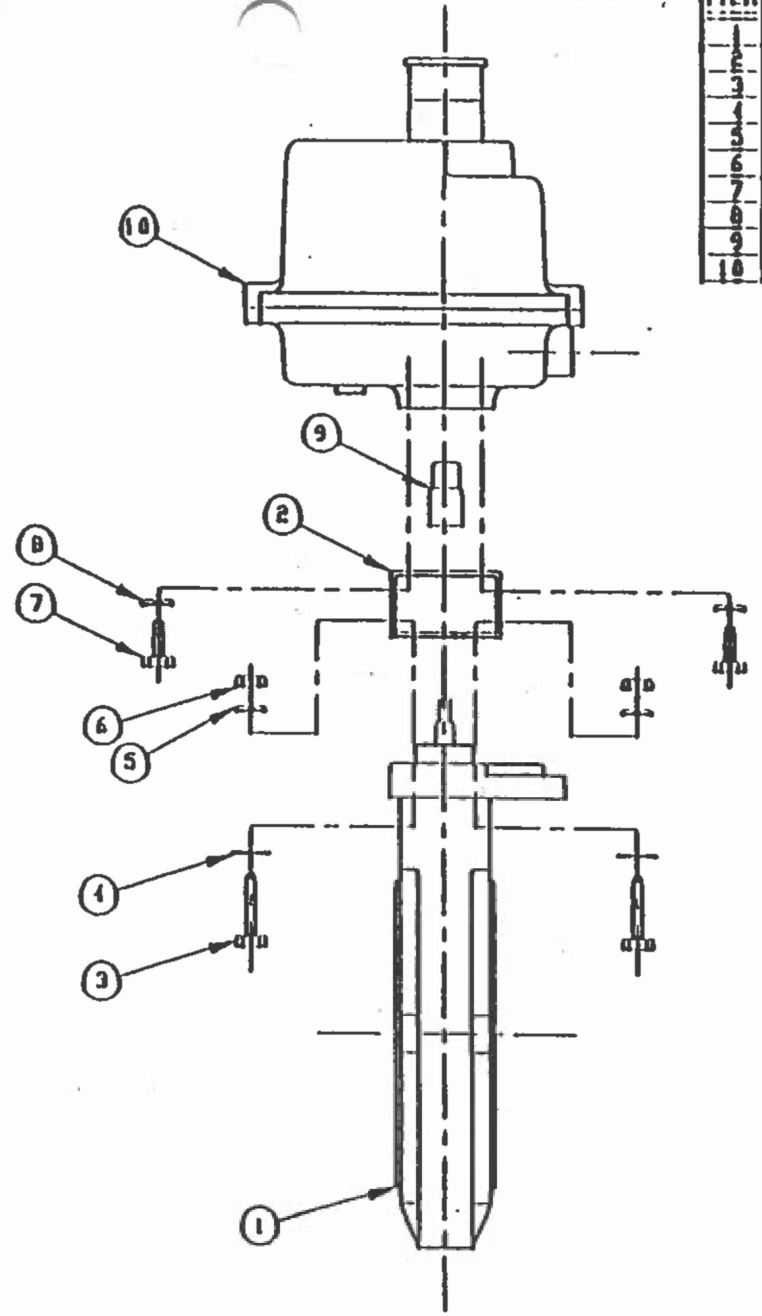
QUARTER MASTER CHIEF DC WIRING DIAGRAM

SIZE	DWG. NO.	REV
A	01792DC	

SCALE NTS SHEET 1 OF 1

VALVE SIZE	H	C
1 1/2"	3.7[illegible]	[illegible].00
2"	3.86	5.00
2 1/2"	3.66	5.50
3"	3.94	5.70
4"	4.53	6.56
5"	5.00	8.05
6"	5.63	8.76
8"	CONSULT FACTORY	





ITEM	DESCRIPTION	MATERIAL
1	BUTTERFLY VALVE	
2	BRACKET MOUNTING	ANODI[illegible]ED ALUM.
3	SCREW	300 SS
4	WASHER FLAT	300 SS
5	WASHER LOCK	300 SS
6	NUT HEX	300 SS
7	SCREW	300 SS
8	WASHER LOCK	300 SS
9	ADAPTER	ANODIZED ALUM.
10	ACTUATOR	ALUM. EPOXY COATED

UNLESS OTHERWISE SPECIFIED

MATERIAL: SEE PART LIST

ASAHI/AMERICA

BUTTERFLY VALVE WITH SERIES 92 ELECTRIC ACTUATOR

DWG. NO. 1265

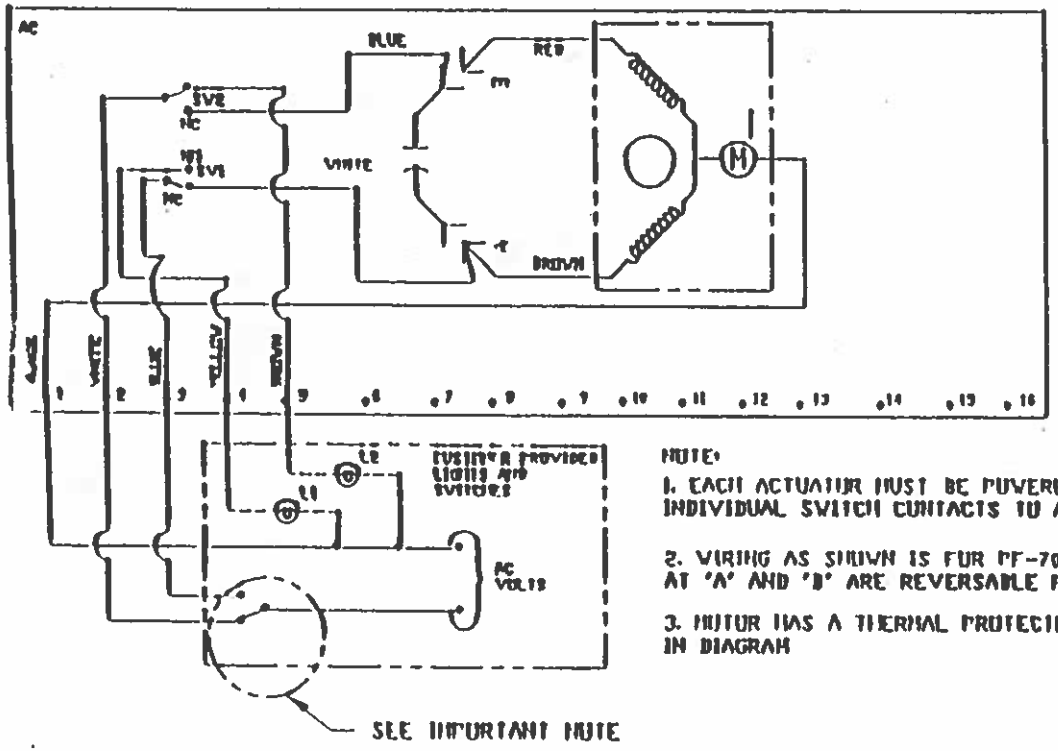
SCALE: NONE

SHEET 1 OF 1

DO NOT SCALE DRAWING

AC WIRING DIAGRAM

ACTUATOR SHOWN IN COUNTER-CLOCKWISE EXTREME OF TRAVEL, OR 'OPEN' POSITION



NOTE:

1. EACH ACTUATOR MUST BE POWERED THRU ITS OWN INDIVIDUAL SWITCH CONTACTS TO AVOID CROSS FEED

2. WIRING AS SHOWN IS FOR PF-700 MOTOR LEADS AT 'A' AND 'B' ARE REVERSABLE FOR PF-1100

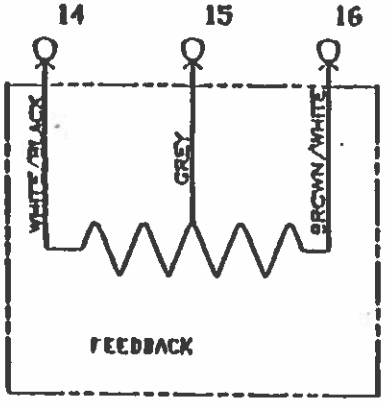
3. MOTOR HAS A THERMAL PROTECTOR AS SHOWN BY (T) IN DIAGRAM

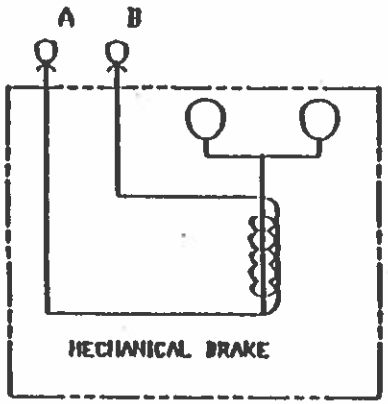
	NAME	DATE
DR	MJ	11/15/93
CHK		
APVD		
FILE	S92\WIRING	

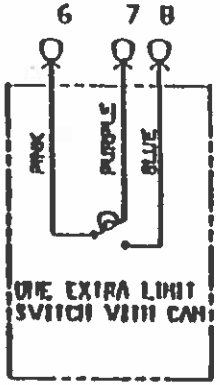
ASAHI/AMERICA
19 GREEN STREET, P.O. BOX 853, MALDEN, MA.

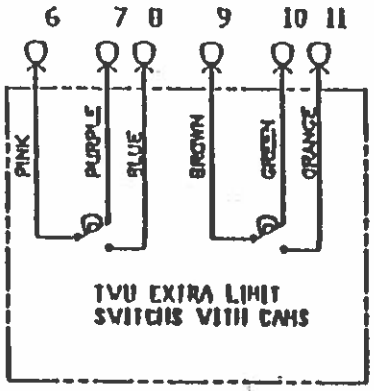
QUARTER MASTER CHIEF AC WIRING DIAGRAM

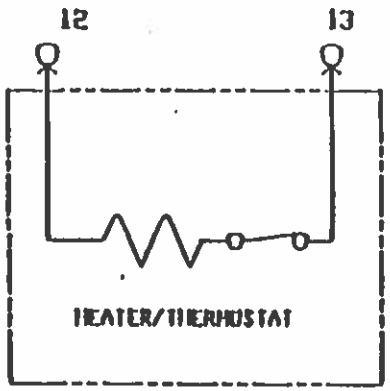
SIZE	DWG. NO.	REV
A	006S92	A
SCALE 1=1		SHEET 1 OF 1











	NAME	DATE
DR	VH	4/11/94
CHK		
APPD		
FILE	S92\083S92	

ASAHI/AMERICA

19 GREEN STREET, P.O. BOX 653, MALDEN, MA.

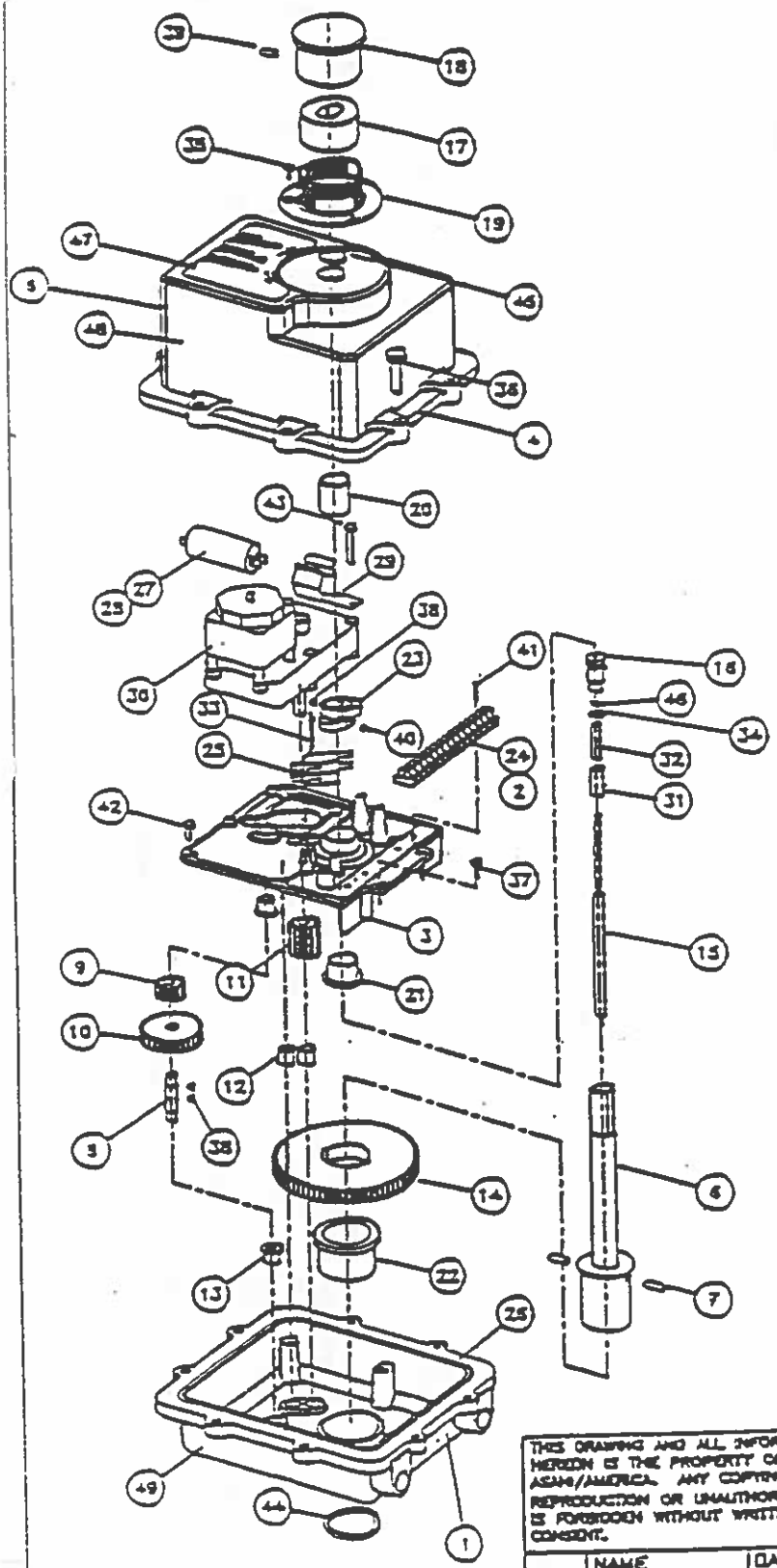
QUARTER MASTER CHIEF OPTIONS WIRING DIAGRAM

SIZE	DWG. NO.	REV
A	083S92	

SCALE 1 SHEET 1 OF 1

SERIES 92

PARTS LIST & MATERIALS OF CONSTRUCTION



ITEM	PART NO	QTY	QTY	DESCRIPTION
1	74019220	1	1	BASE
2	74014460	1	1	WIRING HARNESS
3	74021080	1	1	BASE PLATE
4	74019460	1	1	COVER
5	74019240	1	1	WIRING DIAGRAM LABEL
6	74019220	1	1	SHAFT MAIN
7	74021800	1	1	SHAFT STUB
8	74021280	2	2	PIN
9	74021220	-	1	SPUR GEAR 18
10	74020003	-	1	SPUR GEAR 72
11	74020002	-	1	GEAR PINION
12	74021400	1	1	BEARING PINION
13	74021540	1	1	BEARING PL - SPUR GEAR
14	74020004	-	2	GEAR MAIN
15	74021200	1	1	SHAFT INNER
16	74021200	1	1	SHAFT REDUCER
17	74021180	1	1	KNOB LOWER
18	74021300	1	1	KNOB UPPER
19	74021320	1	1	COLLAR
20	74021260	1	1	BEARING UPPER [illegible]
21	74021120	1	1	BASE PLATE BEARING
22	74021080	1	1	BASE BEARING
23	74021220	1	1	CAM
24	74021420	2	2	TERMINAL BLOCK
25	74021440	2	2	SWITCH ACTUATOR
26	74021540	1	1	O-RING BASE/COVER
27	74020004	-	1	CAPACITOR 4.7 mfD
28	74021845	1	-	CAPACITOR 12 mfD
29	74021320	1	1	CLAMP CAPACITOR
30	74021340	1	1	MOTOR
31	74021250	1	1	SHELL
32	74021220	1	1	SPRING
33	74021420	2	2	SCREW ROUND HD. 4-40 X 1.00 LG
34	74021240	1	1	WASHER, FLAT #10 .460A X .047HK
35	74021680	3	3	SCREW FLAT HD. 6-32 X .25 LG SS
36	74021640	8	8	SCREW HEX HD. 5/16-18 X 1.0 SS
37	74021321	1	1	SCREW SELF TAP (GREEN) #10X .5LG
38	74021880	1	3	KEY, WOODRUFF 3/32
39	74021700	1	1	SCREW SLOT SET 6-32 X .5 LG SS
40	74021740	4	4	SCREW SET 6-32 X .12 LG
41	74021600	4	4	SCREW SELF TAP #4X .5LG
42	74021680	3	3	SCREW SELF TAP SLOT/HEX #10X .5LG
43	74021720	4	4	SCREW SLOT/HEX 10-32 X 1.62 LG
44	74021040	1	1	SEAL BASE
45	74021140	1	1	SEAL COVER
46	74021580	1	1	O-RING SHAFT
47	74021850	1	1	OVERRIDE LABEL
48	74021240	1	1	COVER NAMEPLATE
49	74021970	1	1	BASE NAMEPLATE

	NAME	DATE
DR	T CASTLES	4/92
CHK		
APPD		

FILE \ACAD11\S92\ASAHI92

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ASAHI/AMERICA

19 GREEN STREET, P.O. BOX 651, MALDEN, MA.

SERIES 92 EXPLODED VIEW

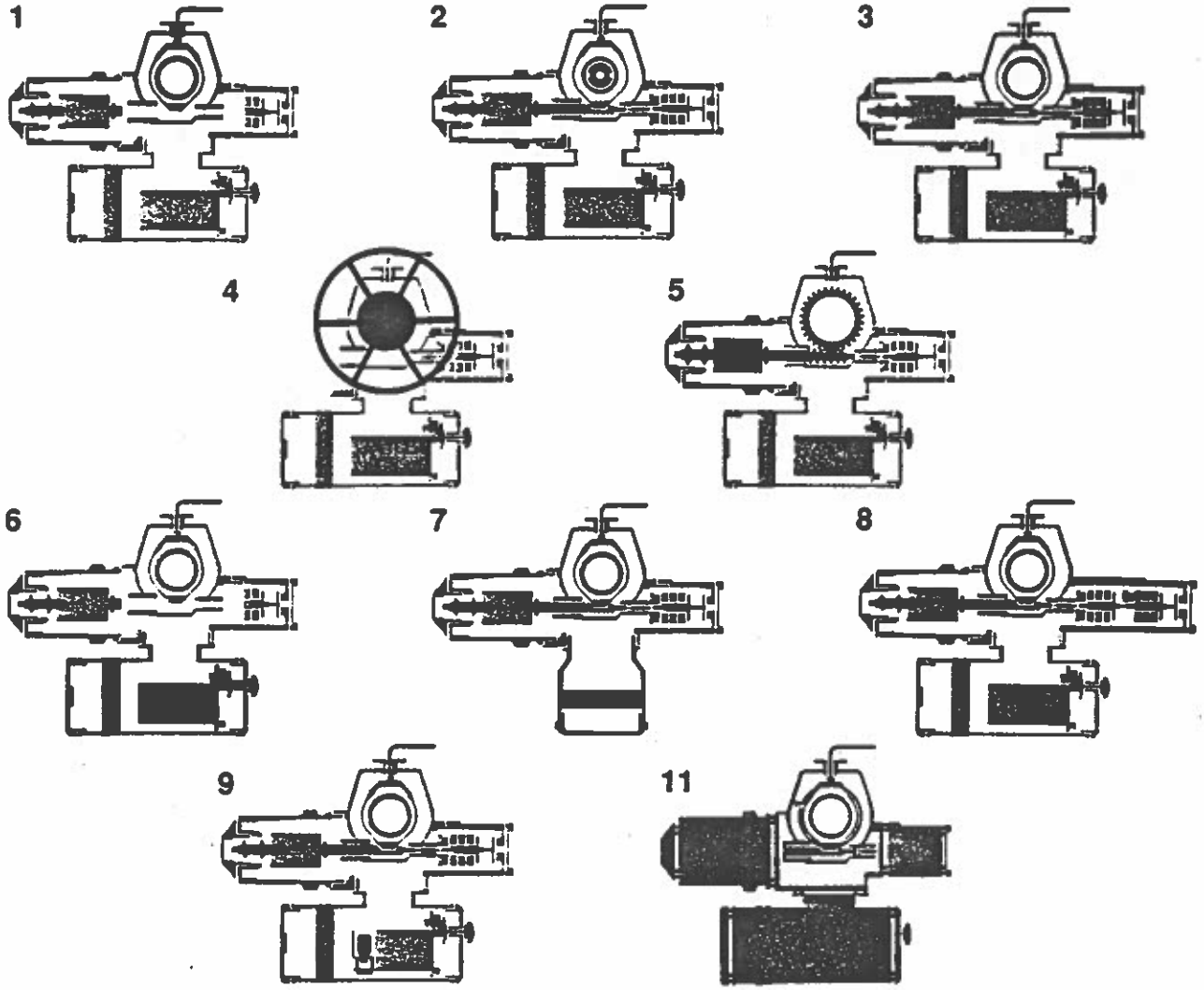
SIZE A | DWG. NO. | REV

SCALE NTS | SHEET 1 OF 1

rotork actuation

Maintenance and spare parts manual for A Range Actuators

Catalog section 5
Publication number AE5/4
Date of issue 11/89



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4	Handwheel	AE5/4.4
5	Motor and wormgear	AE5/4.5
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8	AOP1	AE5/4.8
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	Spare parts stock guide	AE5/4.21
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Actuator serial number

Rotork policy is to supply complete tested sub-assemblies in the place of separate spare parts to ensure maximum field reliability.

Actuator serial number

Complete the inside cover of this manual with the serial numbers of your actuators.

Always use serial numbers in correspondence or questions concerning your actuators.

Rotork's policy: supply of parts for actuators

Rotork's policy is to supply complete sub-assemblies (and certain major parts) rather than supply individual spare parts. This policy has been adopted as the solution most likely to insure the reliability of the actuator after repair.

Other advantages include:

1 Commonly required sub-assemblies are kept in stock ready packed for shipment, to give 'by return' service.

2 New sub-assemblies can be fitted to the actuators with a minimum of fitting or problems.

3 Sub-assembly sheets give detailed illustrated instructions for removing and fitting new sub-assemblies.

4 Ease of customers' spare parts inventory control.

5 Rotork's policy is to use field experience to improve the reliability of actuators. This may mean improvement or changes in component parts, but past or future changes in a sub-assembly will not affect the interface of the sub-assembly with the rest of the actuator.

6 New sub-assemblies incorporate all improvements or modifications and an actuator incorporating a replacement sub-assembly therefore incorporates up to date technology.

7 Rotork's spare sub-assemblies include all parts needed for interface with actuators and full fitting instructions.

8 Sub-assemblies are individually packaged and suitable for stocking and are clearly labelled with contents.

Old model actuators

This manual covers Rotork actuators currently being shipped, and shipped since 1966 with the exception of 6A and 12A units.

Refer to Rotork for parts of actuators shipped before this date and Type 6A and 12A actuators.

In cases where sub-assemblies cannot be fitted we recommend replacement with a new Rotork actuator incorporating current Rotork technology.

Computer coding of actuators and parts

Computer coding in computer controlled parts inventory systems makes it possible to record all the relevant information of an actuator in addition to the serial number. In a large installation, identical actuators can be coded together with individual serial numbers and site reference codes. Information for actuator coding should include:

1 Site reference
2 Serial numbers
3 Actuator size and type
4 Enclosure (WP, EP, FLP, or WT)
5 Voltage
6 Output speed (rev/min)
7 Wiring diagram number
8 Details concerning any additional relays
9 Closing direction (clockwise or counter-clockwise)
10 Potentiometer value (in the event of the potentiometer being used)

Example

1 Jetty pump discharge
2 A4638/40
3 14AZ
4 EP
5 460V
6 43 rev/min
7 WD1411.42
8 2 x 50 dc relays
9 Clock
10 48 Ohm pot

Information for parts coding should include the information required for actuator coding in addition to sub-assembly code number. Reference numbers for sub-assemblies will not be designated with new reference numbers.

Recommended spare parts for stock

It is difficult for Rotork to make recommendations for stocking spare parts. Customers' requirements differ according to company policy, remoteness of installation and quantities of actuators installed, etc.

However, we make the following recommendations for use as a guide (for a more complete guide see Spare Parts Stock Guide AE5/4.21 at the back of this manual):

Spare sub-assemblies required for each size and type of actuator	Actuator quantity 1 - 10	11 - 49	50+
1 Gearcase			1
2*Drive bushing		1	3
3 Switch mechanism		2	5
4 Handwheel			1
5 Motor and wormgear	1	2	5
11 Seals 'O' rings and screw kit	2	5	10
Spare sub-assemblies required for total number of actuators installed			
6 Syncropak starter	1	2	5
7 Syncroset terminal housing		1	1
8 Add-on-pak 1		2	5
9 Optional electrical extras		1	3

* Request your valve supplier to thread stem bushing to fit valve stem

Ordering spare parts

Complete and use the pre-printed schedule at the back of this manual to order parts for your Rotork actuator. Remember your Rotork representative cannot process your order for parts if you do not include actuator serial number. It is helpful if you include other information on the actuator nameplate as a double check on the actuator specification under "other reference information" on the order schedule.

Using the order schedule aids order processing and speeds shipment of your requirements. Your Rotork representative can supply you with an up-to-date parts price list.

Spare parts may be ordered from your local Rotork representative, your valve supplier, or directly from Rotork.

Before starting work on Rotork actuator Sub-assembly sheets give detailed instructions on removing and fitting Rotork sub-assemblies.

Always remember to disconnect electrical supply before starting work on the actuator and observe site safety regulations. After repair is completed, refer to Publication AE5/0 for instructions on switch settings and startup. Failure to go through startup procedure correctly may result in damage to the motor operated valve.

Remember that your actuator is only as watertight or explosion-proof as you make it after completing work.

Test the actuator and verify your repair work by running the motor operated valve fully open and fully closed on local control and remote control.

Nuclear type actuators

Rotork Type NA Actuators are Syncroset actuators developed for installation in the containment of a nuclear steam supply system. Special seals and materials are used in many of the components. Please refer to Rotork for spare parts in all cases and refer to NA supplement of this manual.

Rotork field service

Rotork field engineers are available for startup, maintenance and holding instruction seminars for customers' site personnel.

In many cases Rotork will extend the 12 months guarantee on new actuators to two years provided a Rotork field engineer is on site to assist or supervise startup.

Please refer to Rotork for details.

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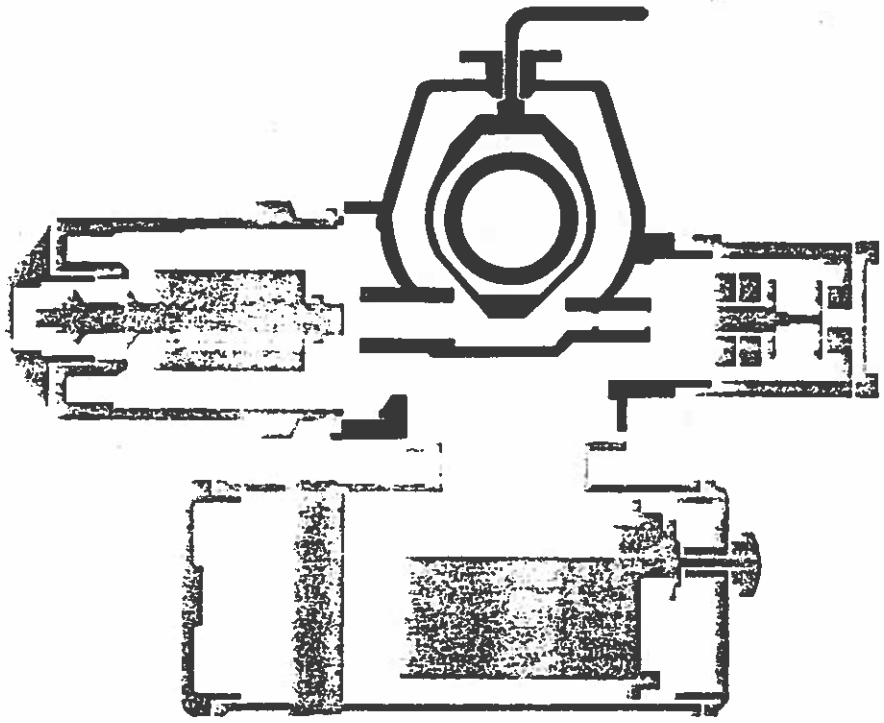
rotork actuation

Maintenance and spare parts manual

Sub-assembly 1 Gearcase for A Range Actuators

Catalog section 5
Publication number AE5/4.1
Date of issue 5/90



The gearcase is the principal actuator sub-assembly and includes all actuator mechanical parts except drive bushing (sub-assembly 2) handwheel (sub-assembly 4) wormgear (sub-assembly 5)

The detailed fitting instructions are common to the whole range of Rotork actuators.

Available parts

1a	Actuator gearcase type A Actuator gearcase type AR Actuator gearcase AB
1b	Base and centre column type A Base and centre column type AR Base and centre column type AB
1d	Gearcase oilseals and maintenance kit

rotork actuation

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Canada, Montreal	(514) 355 3003	(514) 355 0024
Canada, Sarnia	(519) 337 9190	(519) 337 0017
Canada, Toronto	(905) 602 5665	(905) 602 5669
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Germany, Hilden	(02103) 54098	(02103) 54090
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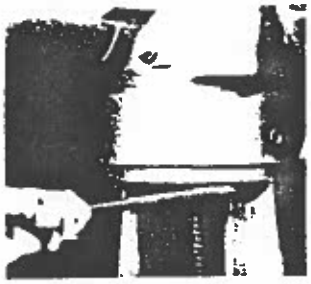
USA, Chicago	(815) 436 1710	(815) 436 1789
USA, Houston	(713) 782 5888	(713) 782 8524
USA, New York City	(201) 646 9596	(201) 646 9288
USA, Philadelphia	(215) 696 7302	(215) 696 7354
Venezuela, Caracas	(2) 323536	(14) 250822

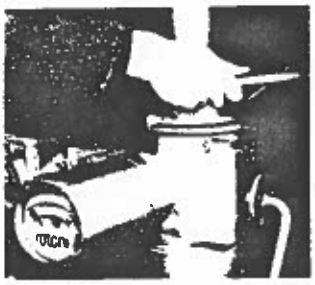


1 All actuators

Dismantling

Before dismantling the actuator disconnect incoming electrical supply to actuator.

Remove stud nuts below valve adaptor or gearbox flange.

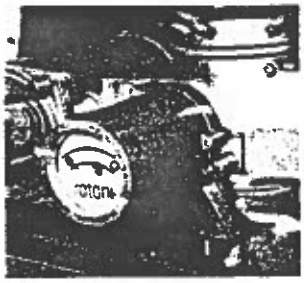


2 All actuators

On clockwise closing rising stem valve, engage HAND and turn hand wheel in closed direction.

Lift actuator off valve when valve stem is disengaged from actuator drive bushing.

If actuator is mounted on keyed shaft simply lift off after removing actuator stud nuts, unless thrust nut is fitted at top of valve stem above drive bushing. This must first be removed after taking off stem cover.



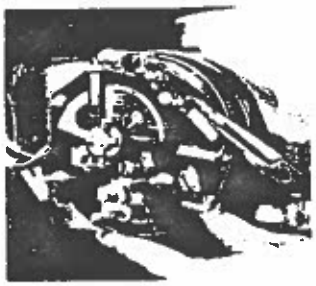
3 All actuators

To drain oil, loosen topmost drain/fill plug in main gearcase before removing lowest drain/fill plug, according to actuator mounting position.

4 All actuators

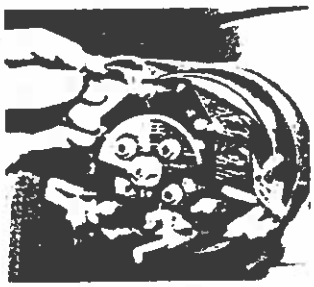
Switch mechanism

Remove 3 retaining screws. Pull off cover squarely.



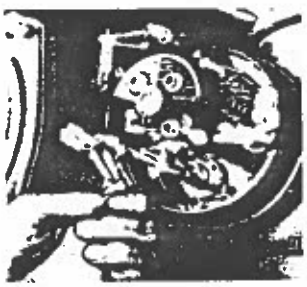
5 All actuators

Disconnect switch leads from mechanism.



6 All actuators

Loosen hexagonal nut and separate lamp assembly from mechanism, after cutting lead fastener. If Add-on-Pak 1 fitted to Syncroset 2 actuator see 23 below.



7 All actuators

Remove 2 capscrews in mechanism backframe and draw mechanism out from gearcase.

8 All actuators

Unclip heater from bracket on switch mechanism.

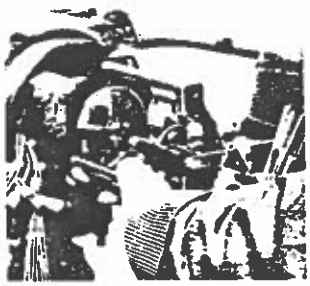
(Actuators supplied to Aug 1982) Actuators after Aug 1982 have heater secured to gearcase, located behind electrical assembly.

9 All actuators

Remove torque plunger from gearcase, noting which end engages with the wormshaft end inside.

10 All actuators with AOP1

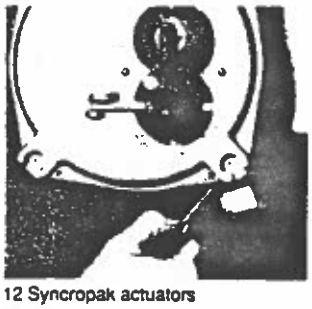
To remove switch mechanism and Add-on-Pak 1 as one assembly, remove capscrews, unclip heater and remove torque plunger. See 7,8,9 above.



11 Actuators with AOP1

Disconnect Add-on-Pak 1 as switch mechanism (see 4 - 8 above)

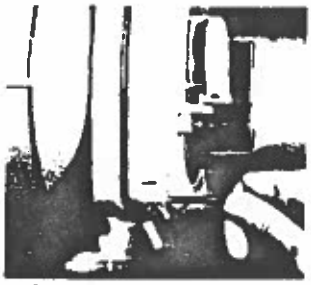
Remove Add-on-Pak 1 and switch mechanism together. This will allow looms to be removed with electrical housing.



12 Syncropak actuators

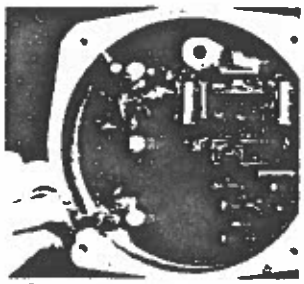
Syncropak actuators

Break Quality Control seal.



13 Syncropak actuators

Remove the 4 retaining screws and take off cover. If necessary use 2 screws in threaded jacking holes to lever off cover.



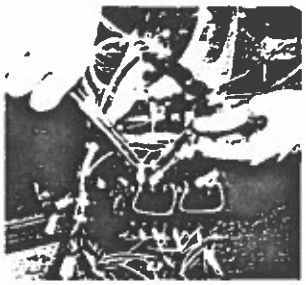
14 Syncropak actuators

Unscrew the 3 frontplate retaining screws and remove rubber spacer (if fitted).

15 Syncropak actuators

16 Syncropak actuators

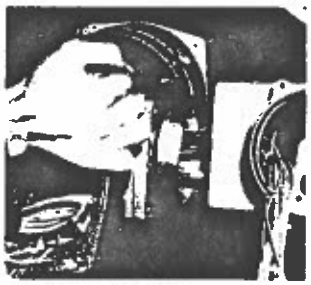
Disconnect the thermostat leads (numbers 5 and 55 in housing).



17 Syncropak actuators

Other actuators

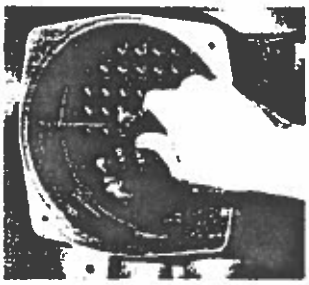
Disconnect motor leads U1, V1 and W1 from reversing contactor block.



18 Syncropak actuators

Remove the 4 capscrews between Syncropak 2 housing, or housing adaptor, and gearcase, using Allen key provided.

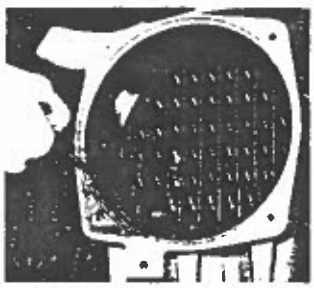
Separate housing from gearcase.



19 Syncroset actuators

Syncroset actuators

Unscrew the earth lug in the housing.



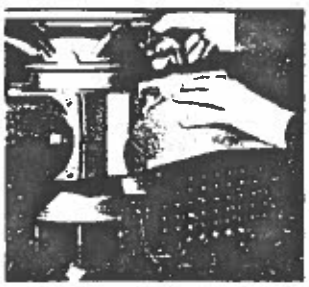
20 Syncroset actuators

Remove terminal bushing retaining ring.

21 Syncroset actuators

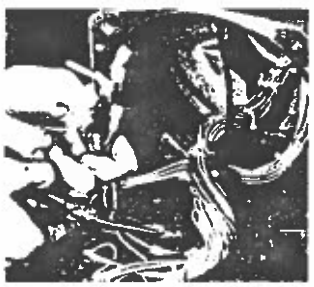
Remove the 4 capscrews between Syncroset 2 housing and gearcase or gearcase adaptor.

Separate housing from gearcase.



22 Syncroset actuators

Withdraw terminal bushing from housing, if necessary by carefully tapping around edge of bushing inside housing using a wooden hammer handle.



23 Syncroset actuators

As an extra check to facilitate reconnection later, make a note of motor lead terminations.

If Add-on-Pak 1 fitted, disconnect Add-on-Pak 1 leads and disconnect motor and thermostat leads nos 33 to 44 from terminal bushing. To remove switch mechanism and Add-on-Pak 1

as one assembly, remove capscrews, unclip heater and remove torque plunger (see 7.8.9 above).

24 Syncroset actuators

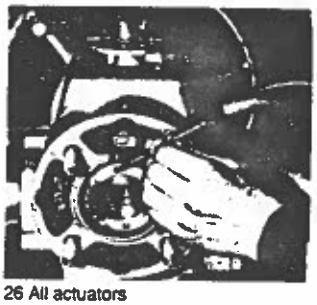
Cut strap that ties switch mechanism harness to motor and thermostat leads. Remove Syncroset housing.

25 All actuators

Drive bushing

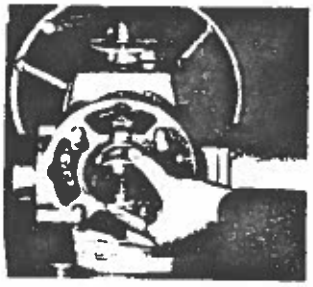
Remove plastic plug and turn actuator output shaft until retainer set screw is visible through hole in actuator base. Loosen set screw, removing completely in case of 7A, 11A and 13A.

AR actuators: no drive bushing retainer fitted. Remove two cap screws holding bushing to output shaft.



26 All actuators

Unscrew retainer.



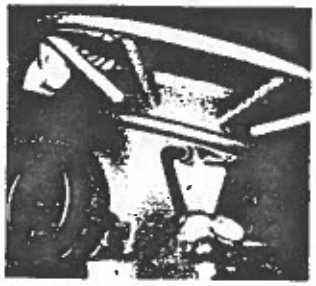
27 All actuators

Remove drive bushing and note position in case of type A actuators.

Position 1 Inserted

Position 2 Extending below base flange.

Illustration shows Position 1.



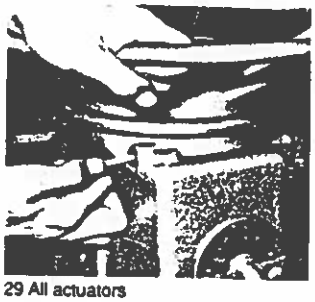
28 All actuators

Handwheel

Slacken off posidrive screw (if fitted) inside hex of capscrew by approximately 1 turn.

Unscrew nylon retainer capscrew.(On earlier actuators remove top cover capscrews and lift off handwheel/top cover assembly).

Refer to sub-assembly 4 for instructions on dismantling side handwheel and bolted handwheel assemblies.



29 All actuators

Rotate handwheel in clockwise direction, while pulling out capscrews and nylon retainer. (On 7A, 11A and 13A rotate in opposite direction).

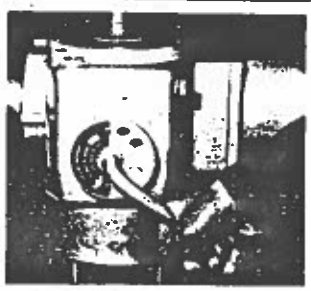
30 All actuators

Lift off handwheel assembly.

31 All actuators

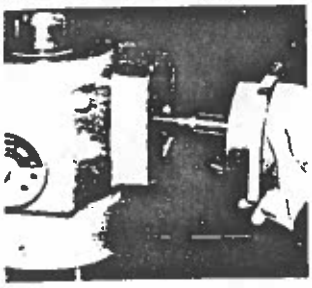
Motor and wormgear

Unscrew the 4 capscrews between motor cover and gearcase.



32 All actuators

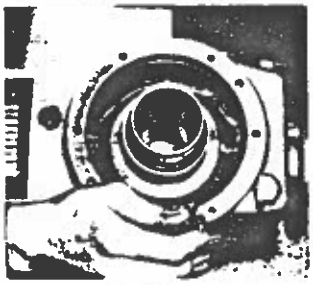
Move clutch lever to hand. Hold and lock in this position.



33 All actuators

To remove motor assembly, pull out motor cover *slowly* and *squarely* from gearcase.

Take care not to damage the gearcase oilseals as threaded part of wormshaft is extracted from gearcase.



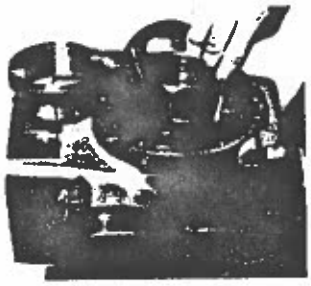
34 14A-95A actuators

Gearcase

Check that clutch finger is lying lengthways on wormwheel. If not push lower end of finger sideways with screwdriver. Clutch spring will return finger to horizontal position.

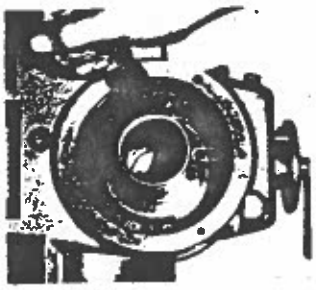
35 14A-95A actuators

To remove gearcase parts press down firmly on spring retaining washer, maintain depressed and remove 'O' ring on output shaft. **Take great care when releasing clutch spring.** Take out clutch spring (and lower washer fitted on some 40A actuators).



36 14A-95A actuators

Slide clutch ring up output shaft and remove. Lift out yoke assembly.



37 14A-95A actuators

Remove the capscrews retaining the thrust pad and remove.

38 14A-95A actuators

Remove wormwheel.

39 7A, 11A and 13A actuators

7A, 11A and 13A actuators

Replacement of gearcase is not advised and should not be attempted unless there is no alternative.

The motor sub-assembly can be dismantled by removing clutch retaining circlip, clutch washer and clutch spring from top of center column.

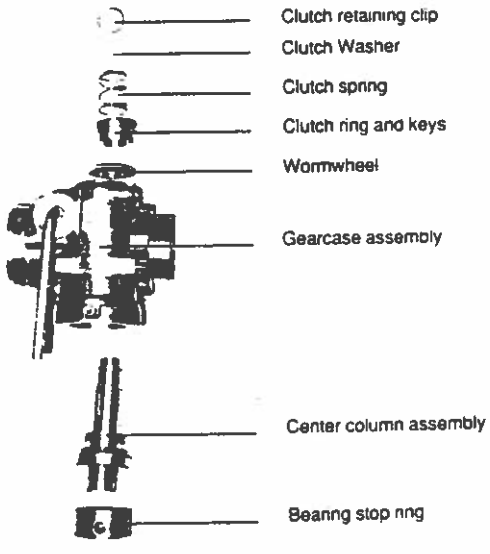
Withdraw clutch ring, avoiding dropping clutch keys into gearcase stump.

Check that the drive bushing retainer is fitted. Screw $^{3}/_{8}$" x $1^{1}/_{2}$" set screw into locating pin at base of actuator and jack out locating pin.

Tap center column from the top to drive it and the bearing stop ring out from the actuator base.

Wormwheel is left free in gearcase and can be removed from the top of the gearcase.

40 7A, 11A and 13A actuators



41 All actuators

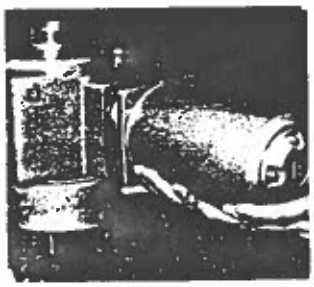
Replacement

Check that 'O' ring seals are undamaged and in correct position before remounting each sub-assembly. Spare seals are supplied.

Remove clutch parts and thrust pad from replacement gearcase as in 34 to 38 above.

Slide original motor wormwheel down output shaft. Replace thrust pad and tighten the retaining screws.

Again check for free rotation.



42 All actuators

Mount motor assembly, meshing carefully wormshaft with wormwheel. Avoid damaging gearcase oilseals. Feed motor and thermostat leads through gearcase for connection in electrical housing.

Ensure that letter 'R' on motor end cap (except on 7A, 11A and 13A actuators) is correctly positioned as shown before replacing 4 motor cover capscrews/washers.

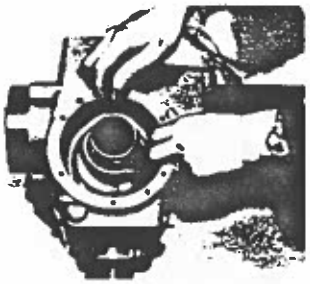
43 14A-95A actuators

Replace clutch yoke. Ensure set screw in yoke is correctly located in hole in thrust pad.

Slide clutch ring/keys down output shaft. Turn output shaft, if necessary, before sliding down clutch rings, so that clutch ring keys come down clear of two clutch yoke lugs.

Make sure that keys are flat on wormwheel before replacing clutch spring. On 40A first replace lower washer, where fitted.

Replace spring retaining washer with flat face downwards. Exercising great care press down on washer until 'O' ring groove in output shaft is above washer. Roll 'O' ring into groove. Slowly release pressure on clutch spring until held by 'O' ring/retaining washer.



44 14A-95A actuators

With clutch finger still flat on wormwheel, check that yoke is correctly positioned, with top of lugs on either side of yoke approx. 0.015" (0.4mm) from engagement under clutch ring collar.

Adjustment is made on set screw to raise or lower yoke. Tighten lock nut on set screw after adjustment.

45 7A, 11A and 13A actuators

7A, 11A and 13A actuators

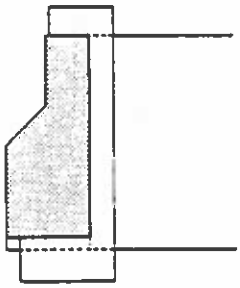
Inspect the oil seal at the bottom of center column.

Place wormwheel, with drive dogs uppermost, against machined face inside gearcase.

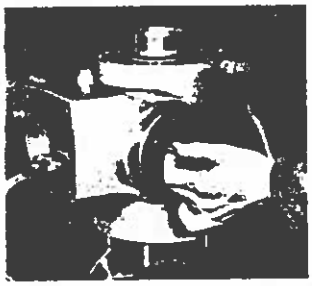
Grease center column oil seal and locate center column up through bottom of gearcase. Check that the wormwheel engages over the shoulder of the center column and also remains against machined gearcase face.

Locate bearing stop ring with spigotted register facing outwards in base of actuator. Line up the two locating pin holes and drive locating pin flush with gearcase: put clutch keys into clutch ring with large lugs matching large diameter.

(see sketch)

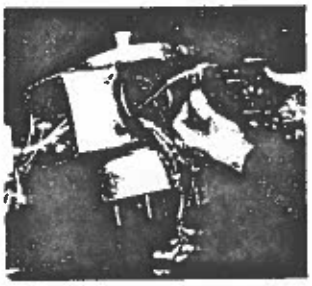


Locate clutch ring assembly over center column. Press clutch spring, clutch washer and circlip retainer over center column so that retainer located in the center column groove.



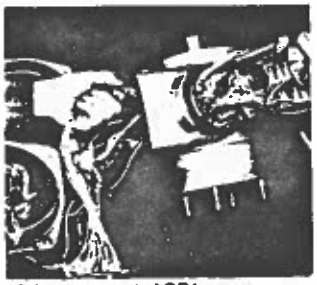
46 All actuators

Push torque shaft into gearcase, with the same end inside as noted under 9.



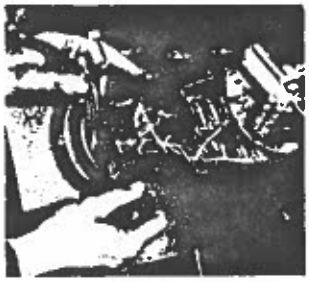
47 All actuators

Position Syncropak 2 or Syncroset 2 housing close to gearcase. Feed heater, switch mechanism and lamp leads (Syncropak only) through gearcase to switch mechanism. Clip heater into bracket on back of switch mechanism.



48 Actuators with AOP1

If Add-on-Pak 1 fitted feed leads through gearcase, under switch mechanism leads towards starter housing. Ensure all leads move freely between switch mechanism and gearcase.



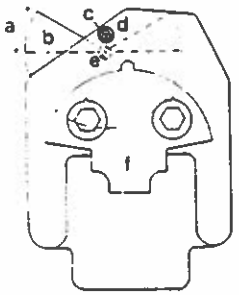
49 7A-40A actuators

Remount switch mechanism. Ensure that torque shaft locates in helix guide.

Tighten one capscrew only in mechanism back plate and check that frontplate is vertical (Arrow on frontplate should be opposite arrow on mechanism frame).

The torque selection adjusters should be set to minimum setting and the valve seated. If the valve fails to seat, the torque setting should be increased until satisfactory seating is achieved.

50 70A-95A actuator

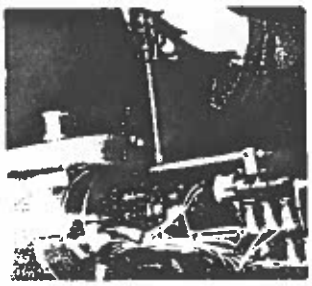


a Range of ratio plate adjustment
b Ratio plate
c Locking screw
d Access hole in front plate for ratio plate adjustment
e Ratio plate adjusting screw
f Torque adjusting frontplate

If the torque selection adjusters have been increased to max. setting and the valve still fails to seat the ratio plate may need adjustment. The switch mechanism need not be removed. Release screw C and move the ration plate clockwise by turning a screwdriver in the slot in the end of shaft E. Re-tighten the ration plate retaining screw C and check that the torque adjusting front plate is vertical (see 49).

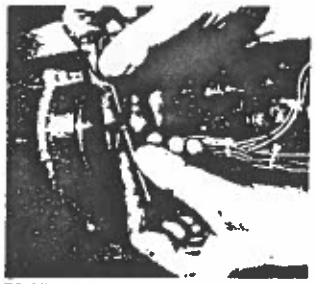
To check adjustment set the torque selectors to min. and seat the valve noting the motor current just before the actuator trips off on torque switch control. Gradually increase the torque setting until this current reaches the full load current. This should be achieved at max. torque setting, and if not re-adjust ratio plate as previously and repeat.

Note: Any movement of the ration plate must be made in small increments as this setting is critical. It will be found easier to adjust the ratio plate if the load on the plate is relieved by moving the torque adjusting front plate clockwise whilst carrying out adjustments.



51 All actuators

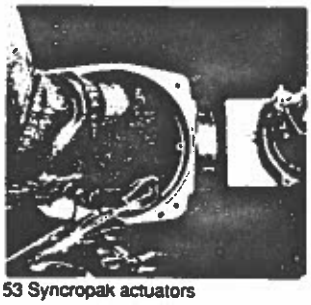
If frontplate is not vertical remove capscrew in backplate, draw mechanism away from gearcase. Remove torque plunger.



52 All actuators

Adjust screw length on torque shaft. Using two wrenches (6BA). Increasing overall length will cause frontplate to rotate clockwise when the mechanism is viewed from front. Decreasing length will allow mechanism return spring to deflect frontplate counterclockwise. Do not forget to tighten lock nut securely with a wrench.

Tighten two capscrews between mechanism backplate and gearcase.



53 Syncropak actuators

Syncropak housing

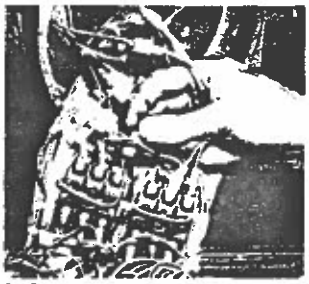
Feed motor and thermostat leads through into Syncropak housing. Ensure that the 'O' ring is in position on the housing spigot before mating up to gearcase. Hold leads in middle of spigot and remount housing on gearcase. Replace 4 retaining screws and washers using Allen key provided.

54 All actuators

Reconnect switch mechanism leads and lamp assembly by referring to code card or wiring diagram. Replace mechanism cover and 3 retaining screws.

55 Syncropak with AOP1

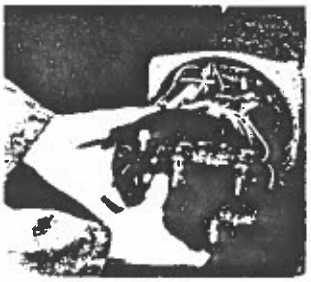
If Add-on-Pak 1 is fitted, butt connect lamp lead (no. 60) in starter housing. Check Add-on-Pak 1 lead nos. on Wiring code card and connect to back of bushing, with aid of a flashlight.



56 Syncropak actuators

Reconnect thermostat leads (nos. 5 and 55) in housing.

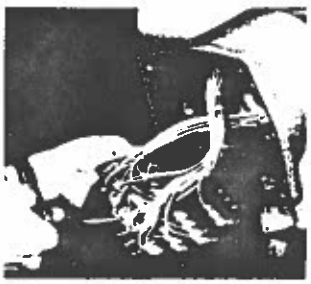
Refer to sketch of motor terminations and reconnect motor leads. (Actuators with A prefix serial numbers - connect terminators to block under chassis).



57 Syncropak actuators

Replace starter chassis making sure that slide rails engage with channels in housing and that no wires in the harness are pinched. Push home, replace 3 retaining screws and rubber spacer, if fitted.

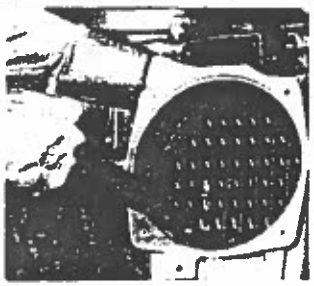
Replace starter cover.



58 Syncroset actuators

Syncroset housing

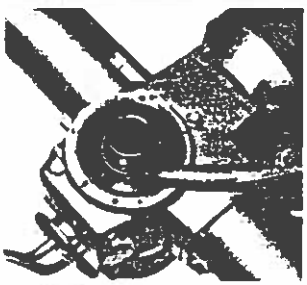
Before replacing terminal bushing in housing reconnect heater, motor and thermostat leads. If Add-on-Pak 1 fitted connect wiring harness to terminal bushing.



59 Syncroset actuators

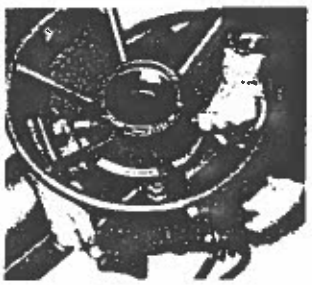
Replace terminal bushing. Before tapping back to shoulder in housing check that no leads can be pinched between bushing and shoulder. Remount housing on gearcase and replace the 4 retaining screws. Replace bushing retaining ring and grounding lug.

Reconnect leads to switch mechanism.



60 All actuators

Fill main gearcase with oil (SAE 80 EP) to just below inside top of gearcase.



61 All actuators

Make sure that two capscrews or drive dogs on bottom of handwheel hub are not positioned directly above keys on clutch ring.

Feed nylon retainer into gearcase while turning handwheel counter clockwise. (Clockwise for 7A, 11A and 13A actuators.)

Tighten capscrew and then pozidrive screw.

On earlier actuators ensure 'O' ring is correctly positioned under top cover before replacing handwheel assembly.

62 All actuators .

Replace retaining screws.

Ensure that gearcase spigot is dirt free and that the 'O' ring is in position before replacing indicator cover and 3 retaining screws.

63 All actuators

When replacing drive bushing make certain that actuator output shaft drive dogs are in full engagement with bushing, and that type A is in correct position as noted under 27.

64 All actuators

Replace retainer, hammer tight and lock in position. Engage hand and turn handwheel until set screw is visible through hole in actuator base. Tighten retainer set screw.

65 All actuators

Stamp actuator details on new nameplate.

Rivet new nameplate in position.

66 All actuators

Engage HAND and hand wind in both directions to check correct operation.

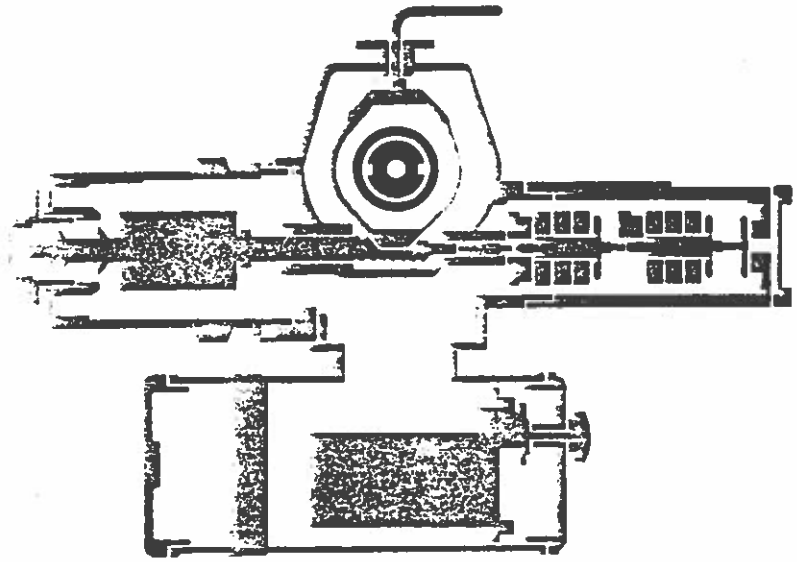
For electrical start-up, refer to section 6 of Instruction Manual AE5/0.

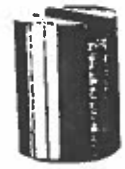
rotork actuation

Maintenance and spare parts manual

Sub-assembly 2 Drive bushing and bushing retainer for A Range Actuators

Catalog section 5
Publication number AE5/4.2
Date of issue 10/90



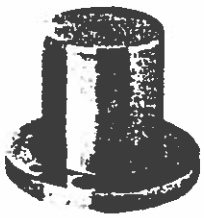


2c

2d

2a

2b



2e

Rotork A, AR and AZ actuators are supplied with blank drive bushings which are available as spare parts. The valvemaker is usually responsible for machining the blank drive bushing and is therefore, in a position to supply the machined drive bushing to suit the valve stem.

Blank drive bushings are not supplied with Type AB actuators. However, in certian cases Rotork does supply a machined sliding bushing. Contact Rotork with full details of valve as well as actuator to purchase replacement sliding bushing for AB type actuators.

Available parts

2a	Type A blank drive bushing
2b	Type A drive bushing retainer
2c	Type AZ blank drive bushing
2d	Type AZ drive bushing retainer
2e	Type AR blank drive bushing

NB: Type A and AR can be fitted either way up to give:

Position 1 Inserted into output shaft.
Position 2 Protruding below base flange.

rotork actuation

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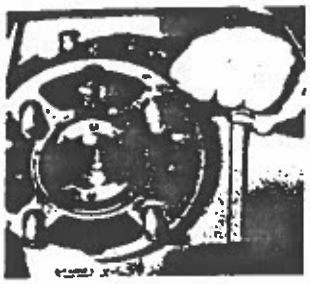
USA, New York City	(201) 646 9596	(201) 646 9288
USA, Philadelphia	(215) 696 7302	(215) 696 7354
Venezuela, Caracas	(2) 323536	(14) 250822

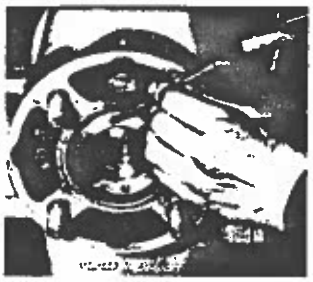


1

Dismantling

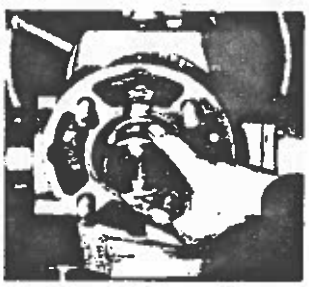
Remove red plug in side of actuator base.
Engage HAND and turn handwheel until retainer set screw is visible through hole in side of actuator base.

Loosen set screw



2

Unscrew retainer and remove. AR stem bushings are attached to output shaft with capscrews. Remove capscrews to detach AR bushing.



3

Remove drive bushing noting position in case of type A or AR actuators.

Position 1 inserted as illustrated above.

Position 2 Protruding below base flange.

4

Replacement

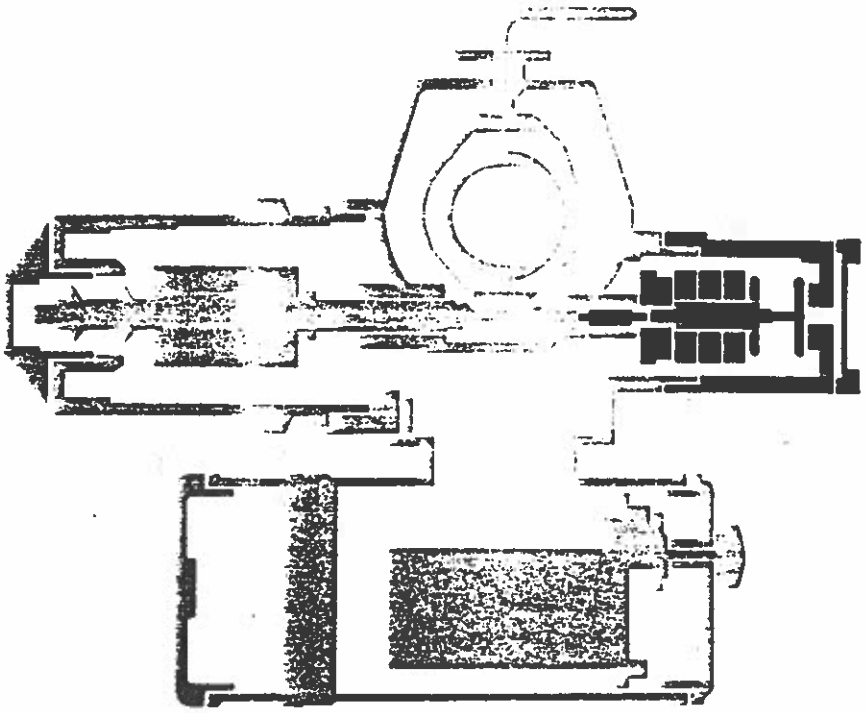
When installing the machined drive bushing insure that actuator output shaft drive dogs are in full engagement with slots in bushing, and Type A position is as noted in instruction paragraph 3.

rotork actuation

Maintenance and spare parts manual

Sub-assembly 3
Switch mechanism

Catalog section 5
Publication number AE5/4.3
Date of issue 3/90



The basic switch mechanism is common to the range of Rotork actuators, 7A thru 95A. Add-on-Pak 1, (an optional extra) comprising two switch banks and potentiometer, can be fitted to the standard switch mechanism for additional switch functions, switching during travel or remote position transmission. Details of fitting and operation of Add-on-Pak 1 are given in Sub-assembly 8 (AE5/4.8). Actuators with Add-on-Pak 1 fitted must have the Add-on-Pak removed before working on or replacing the switch mechanism.

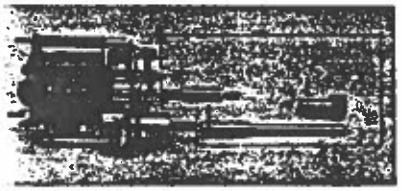
The adaptation kit comprises the parts needed for the interface between the switch mechanism and the actuator gearcase and gearing.

Available parts

3a	Switch mechanism
3a/1	Switch mechanism adaption kits (specify parts list number)
3b	Switch banks (2 sets of 3)
3c	Switch mechanism and indicator cover with seals and screws (excluding 3a/1)
3d/1	Indicator dial, pre 1978
3d/2	Indicator dial, current design
3e	Potentiometer transmitter
3f	C.P.T.

Part 3a Switch mechnism with **3a/1** adaption kit for 7A, 11A and 13A actuators. Adaption kit is parts list no. PL50375.

Part 3a Switch mechanism with **3a/1** adaption kit for 14A-40A actuators. Adaption kit parts list nos are as follows:
14A-16A actuators PL 50376
30A actuators PL 50377
40A actuators PL 50378



Part 3a Switch mechanism with **3a/1** adaption kit for 70A-95A actuators. Adaption kit is parts list no. PL 50379

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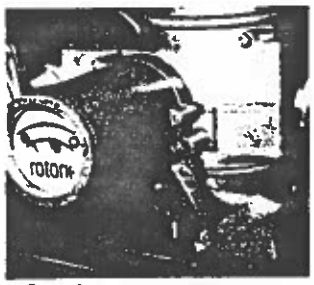


1 Parts 3a, c

Dismantling

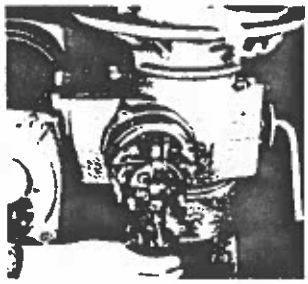
Isolate incoming electrical supply to actuator. To drain oil loosen topmost fill/drain plug in gearcase before removing lowest fill/drain plug according to actuator mounting position. If actuator is side mounted with indicator cover pointing vertical upwards, oil need not be drained.

2 Parts 3a, c, d

Remove 3 retaining screws and pull off indicator cover squarely.

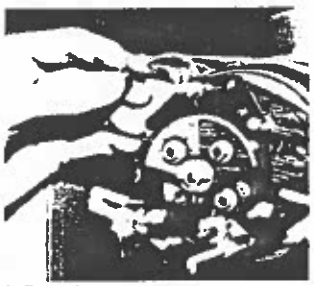
3 Parts3a, c

If actuator is 'torqued off' in open or closed position, 'torque adjusting' frontplate will not be vertical.



4 Part 3a, c

Move hand/auto lever into HAND position to center torque adjusting frontplate if necessary.

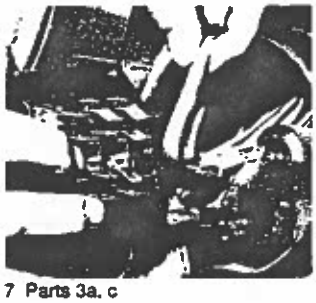


5 Parts 3a, c

Disconnect leads from switches. Separate lamp assembly from mechanism (SyncroPak actuators only) by loosening hexagonal nut and washer.

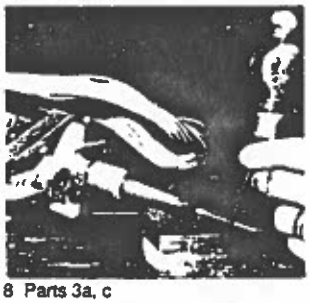
6 Part 3a, c

Remove 2 capscrews in mechanism back frame and withdraw mechanism from gearcase.



7 Parts 3a, c

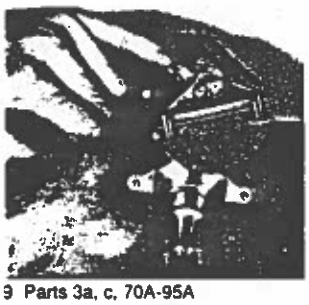
Unclip heater from bracket before removing mechanism.



8 Parts 3a, c

Remove limit switch drive gear from damaged mechanism. Drill through LS shaft on switch mechanism using hole in LS gear guide. Ensure that LS gear is held hard against switch mechanism brass location bush while drilling, and that mating shaft in switch mechanism is pushed through to full extent to eliminate any end float.

A spare pin is provided to fix gear shaft.



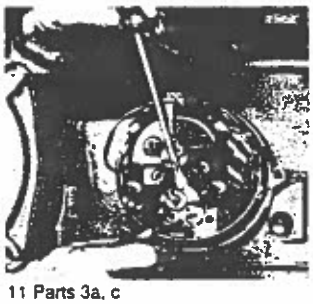
9 Parts 3a, c, 70A-95A

On 70A-95A actuators only, check that exact angular position of ratio plate on old switch mechanism and adjust ratio plate on new mechanism to similar position.

10 Parts 3a, c

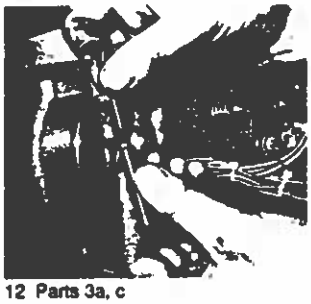
Replacement

Clip heater into bracket on replacement mechanism and mount mechanism in gearcase. On 7A to 40A actuators insure that torque shaft in gearcase engages in helix guide at back of mechanism.



11 Parts 3a, c

Replace one only capscrew in mechanism backplate. Tighten and check that torque adjustingfrontplate turns to vertical position. Torque adjusting frontplate must rotate towards the vertical position as mechanism is pressed against gearcase.

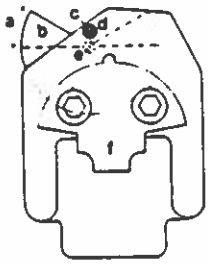


12 Parts 3a, c

If not in vertical or torqued-off position, remove capscrew in backplate, draw mechanism away from gearcase, and remove torque shaft.
Adjust screw length on torque shaft. Increasing overall length will cause frontplate to rotate clockwise when the mechanism is viewed from the front. Decreasing length will allow mechanism return spring to deflect frontplate counter-clockwise. Don't forget to tighten lock nut with spanner.

13 Parts 3a, c 7A-40A

After adjustment, tighten two capscrews between mechanism backplate and gear case.
The torque selection adjuster should be set to minimum setting and the valve seated. If the valve fails to seat, the torque setting should be increased until satisfactory seating is achieved.



14 Parts 3a, c, 70A-95A

- a Range of ratio plate adjustment
- b Ratio plate
- c Locking screw
- d Access hole in frontplate for ratio plate adjustment
- e Ratio plate adjusting screw
- f Torque adjusting frontplate

If the torque selection adjusters have been increased to max. setting and the valve still fails to seat the ratio plate may need adjustment. The switch mechanism need not be removed. Release screw c and move the ratio plate clockwise by turning a screwdriver in the slot end of shaft e. Re-tighten the ratio plate retaining screw c and check that the torque adjusting frontplate is vertical (see 12).

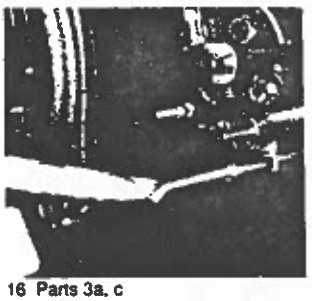
To check adjustment set the selectors to min. and seat the valve noting the motor current just before the actuator trips off on torque switch control. Gradually increase the torque setting until this current reaches the full load current. This should be achieved at max. torque setting, and if not re-adjust ratio plate as previously and repeat.

Note: Any movement of the ratio plate must be made in small increments as this setting is critical. It wil be found easier to adjust the ratio plate if the load on the plate is relieved by moving the torque adjusting front plate clockwise whilst carrying out adjustments.

15 Parts 3a, c

Reconnect switch leads. If necessary check lead numbers on Wiring Code Card on back of terminal compartment cover. Remount lamp assembly (SyncroPak only).

Refer to section 4 of your instruction manual AE5/0 for setting the switch mechanism.



16 Parts 3a, c

Ensure that indicator drive on switch mechanism is identical to spare supplied with cover. If not replace by spare.

17 Parts 3a, c

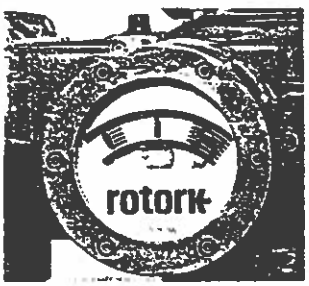
Check that gearcase spigot is dirt free and that the 'O' ring is in position before fitting replacement cover. Indicator dial must be vertical relative to actuator output shaft. Ensure that indicator drive engages into dial mechanism by lining up and adjusting on cover fitting lugs.

18 Part 3d/1

Indicator dial design, pre 1978

19 Part 3d/2

Indicator dial design 1978-1989

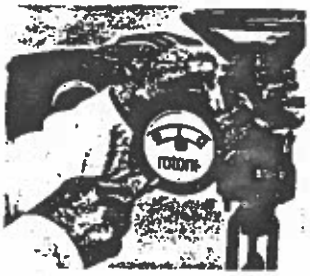


20 Part 3d/3

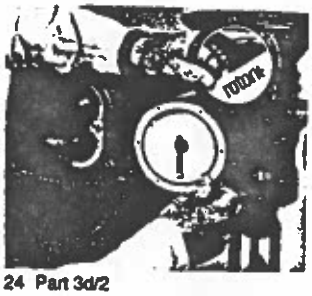
Indicator dial, current design.

21 Part 3d/1

22 Part 3d/1



23 Part 3d/2



24 Part 3d/2

Replacement

To replace the indicator dial, remove the six capscrews at the end of indicator cover and remove clamp ring.

Pry out the damaged dial and sealing ring.
Ensure indicator cover is clean and dry before fitting new sealing ring and dial. Make sure that red pointer is in middle of dial before replacing clamping ring and six retaining screws.

To replace indicator dial, remove the six screws and lever out damaged dial. Remove 'O' ring seal.

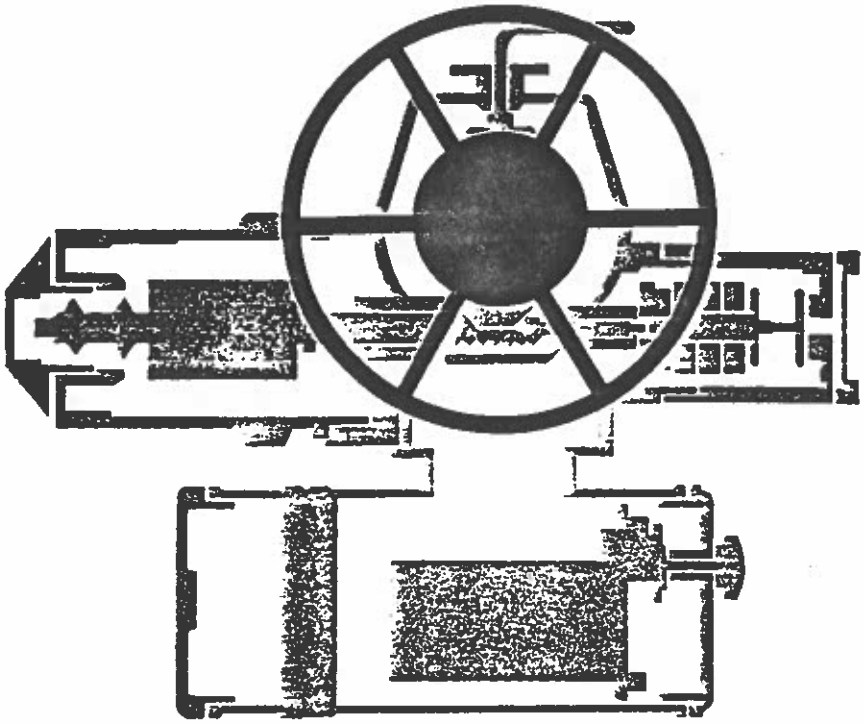
Replace 'O' ring and dial, first ensuring that dial is correctly positioned in relation to the red pointer. Replace the six retaining screws.

rotork actuation

Maintenance and spare parts manual

Sub-assembly 4 Handwheel for A Range Actuators

Catalog section 5
Publication number AE5/4.4
Date of issue 3/90



All Rotork actuators are provided with a handwheel for manual drive. 7A thru 40A actuators are provided with a top handwheel, 70A, 70AR, 90A, 90AR, 91AR and 95A are fitted with a side handwheel. The side handwheel is available as an optional extra on 14A thru 40A and 40AR.

Handwheel drive to the actuator output shaft incorporates backlash or 'hammerblow' to enable stuck valves to be hammered open.

The handwheel assembly is either bolted to the gearcase or fastened with a nylon retaining rod - be sure to specify which when ordering.

Available parts

4a Top handwheel assembly
4b Side handwheel assembly

Rotork Controls Limited
Bath, England
BA1 3JQ
telephone (0225) 428451
fax (0225) 333467, telex 44823

Rotork Controls Inc
19 Jet View Drive
Rochester
New York 14624
telephone (716) 328 1550
fax (716) 328 5848

Rotork Controls (Canada) Limited
telephone Calgary (403) 569 9455
fax (403) 569 9414

Rotork Controls Inc
telephone Houston (713) 782 5888
fax (713) 782 8524

Rotork Motorisation SA
telephone La Courneuve (1) 48 35 44 99
fax (1) 48 35 42 54, telex 234205

Rotork Controls (Deutschland) GmbH
telephone Hilden (02103) 54098
fax (02103) 54090

Rotork Controls (Italia) Srl
telephone Milan (02) 8241001
fax (02) 89200301

Rotork S.L.
telephone Vizcaya (94) 676.42.44
fax (94) 676.48.64

Rotork BV
telephone Netherlands (10) 4146911
fax (10) 4144750

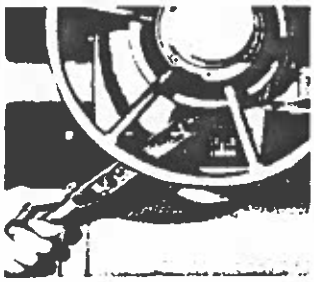
Rotork Controls (Singapore) Pte Limited
telephone Singapore (65) 4571233
fax (65) 4576011, telex 51094

Rotork Controls Limited (Korea branch)
telephone Seoul (02) 7850194
fax (02) 7854482

Beacon Rotork Controls Limited
telephone Madras (44) 652294
telex 4122029

Rotork Arabia Limited
(Saudi Arabia)
telephone Al-Khobar (03) 857-9956
fax (03) 857-7170

Rotork Australia Pty Ltd
telephone Ballarat (053) 381566
fax (053) 381570



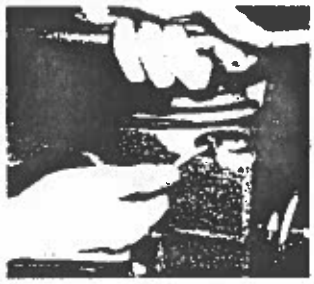
1 Parts 4a, b

Dismantling

4a Top handwheel assembly
If the actuator is not mounted in the vertival position with the handwheel uppermost the gearcase will have to be drained of oil prior to removing the handwheel assembly.

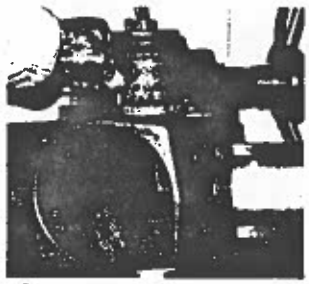
2 Part 4a

For top handwheel actuators slacken off pozidrive screw situated in cap screw hex by one turn. Undo capscrew.



3 Part 4a

Rotate handwheel in clockwise direction while pulling out capscrew and nylon retainer rod.
On 7A, 11A and 13A rotate in opposite direction.

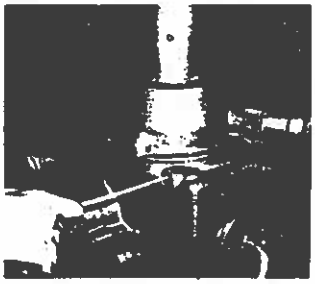


4 Part 4a

Bolted handwheel assembly

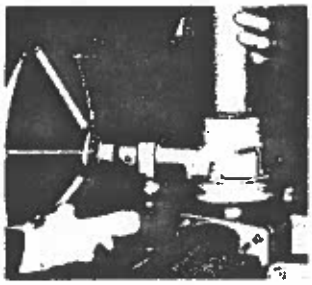
Remove capscrews between top cover and actuator gearcase.

Lift off handwheel assembly.



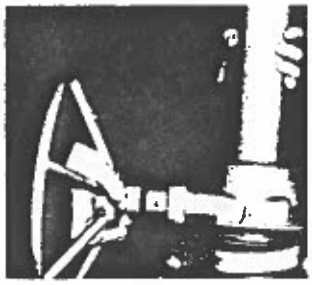
5 Part 4b

For side handwheel assembly unscrew the capscrew and withdraw nylon retainer while turning the handwheel.



6 Part 4b

Tap off side handwheel assembly.



7 Part 4b

Lift off side handwheel assembly.

8 Parts 4a, b

Replacement

4b Side handwheel

Rotate handwheel in clockwise direction, while pulling out capscrew and nylon retainer rod. On 7A, 11A and 13A rotate in opposite direction.

Replace handwheel assembly making sure that two capscrews or drive dogs on bottom of handwheel hub are not positioned directly above keys on clutch ring.

Ensure 'O' ring is correctly positioned under top cover. Replace retaining screws.

For top handwheel feed nylon retainer into gearcase while turning handwheel counter clockwise. Tighten posidrive screw and then tighten capscrew securing nylon retainer rod.

On 7A, 11A and 13A turn handwheel clockwise.

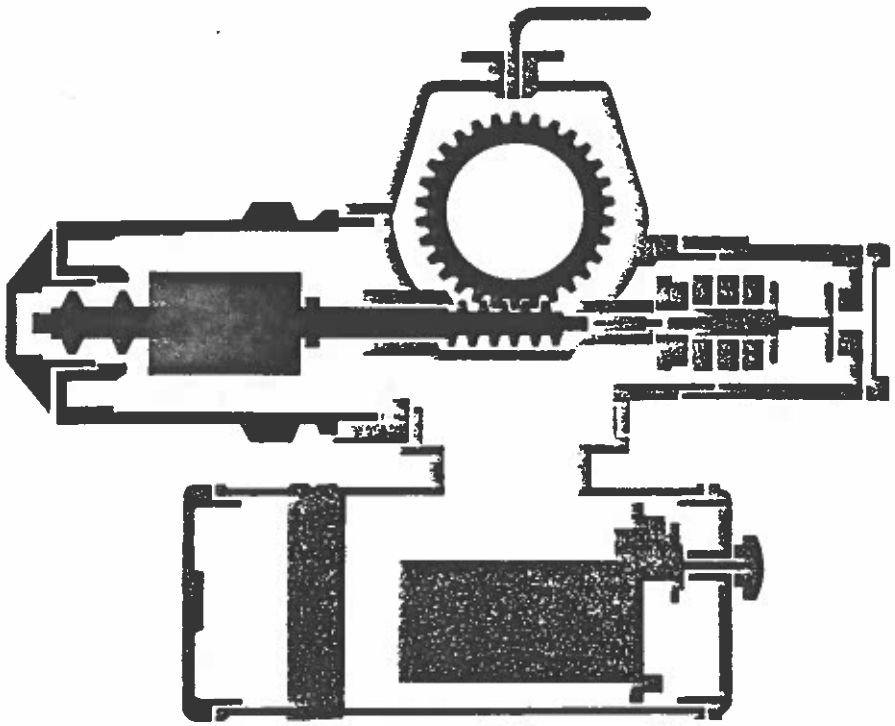
Printed in England by Graphics Interface Ltd, Bath

rotork actuation

Maintenance and spare parts manual

Sub-assembly 5 Motor and Wormgear for A Range Actuators

Catalog section 5
Publication number AE5/4.5
Date of issue 3/90



Sub-assembly 5 comprises the complete motor and wormgear. It is not practical to split this sub-assembly further, because fitting the rotor to the wormshaft and machining the rotor require special tools.

Motor protection is normally assured by a thermostat embedded in the stator winding. The thermostat is wired into the control system on Syncropak units, but with Syncroset units it must be wired to the stop circuit of the reversing contactors.

Items in 5a include replacement oil seals that may be damaged in removing or replacing the sub-assembly. These seals are available as a separate kit for the convenience of customers in the event of their removing the motor stator for repair or rewinding locally.

Available parts

5a Motor and wormgear assembly
Types available:
3 phase
Single phase
D.C.
Modulating duty (type M & ML)

5b Oil seals for motor assembly

Rotork Controls Limited
Bath, England
BA1 3JQ
telephone (0225) 428451
fax (0225) 333467, telex 44823

Rotork Controls Inc
19 Jet View Drive
Rochester
New York 14624
telephone (716) 328 1550
fax (716) 328 5848

Rotork Controls (Canada) Limited
telephone Calgary (403) 569 9455
fax (403) 569 9414

Rotork Controls Inc
telephone Houston (713) 782 5888
fax (713) 782 8524

Rotork Motorisation SA
telephone La Courneuve (1) 48 35 44 99
fax (1) 48 35 42 54, telex 234205

Rotork Controls (Deutschland) GmbH
telephone Hilden (02103) 54098
fax (02103) 54090

Rotork Controls (Italia) Srl
telephone Milan (02) 8241001
fax (02) 89200301

Rotork S.L.
telephone Vizcaya (94) 676.42.44
fax (94) 676.48.64

Rotork BV
telephone Netherlands (10) 4146911
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telephone Singapore (65) 4571233
fax (65) 4576011, telex 51094

Rotork Controls Limited (Korea branch)
telephone Seoul (02) 7850194
fax (02) 7854482

Beacon Rotork Controls Limited
telephone Madras (44) 652294
telex 4122029

Rotork Arabia Limited
(Saudi Arabia)
telephone Al-Khobar (03) 857-9956
fax (03) 857-7170

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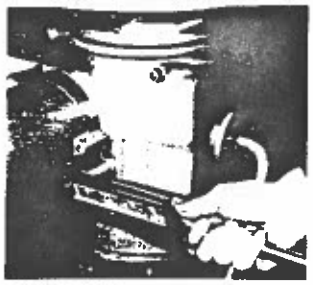
telephone Ballarat (053) 381566
fax (053) 381570



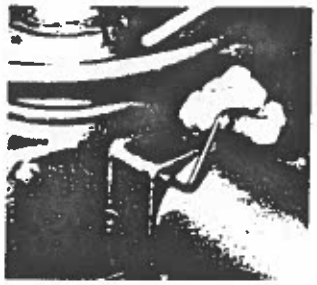
1 All actuators

Dismantling

Isolate incoming electrical supply to actuator. To drain oil loosen topmost fill/drain plug in gearcase before removing lowest fill/drain plug according to actuator mounting position.

2 All actuators

Using the clutch lever place the unit into HAND operation. Hold and lock in this position.



3 All actuators

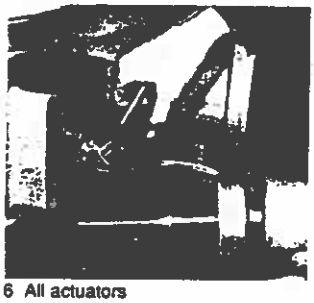
Unscrew the capscrews holding the motor to the gearcase.

4 All actuators

To remove the motor assembly, pull it slowly and squarely from the gearcase, take care not to damage the gearcase oil seals with the threaded section of the motor wormshaft.

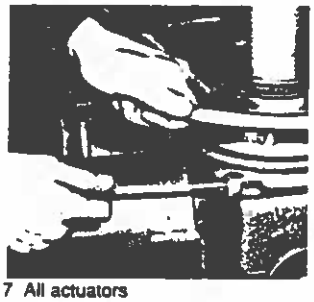
5 All actuators

Cut white lead fastener and slide identification tags along leads and position approximately 8" from stator.



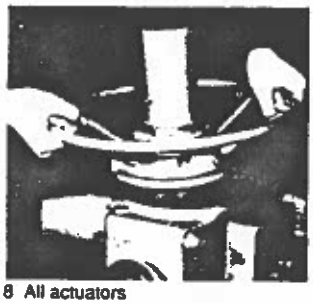
6 All actuators

Cut motor and thermostat leads approximately 6" from stator.



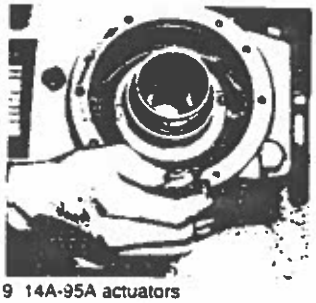
7 All actuators

Unscrew capscrew, and rotate handwheel in clockwise direction while pulling out capscrew and nylon retainer.
On 7A, 11A and 13A rotate handwheel in opposite direction.
On earlier actuators:
Remove top cover capscrews and lift off handwheel/top cover assembly.



8 All actuators

Remove handwheel assembly.



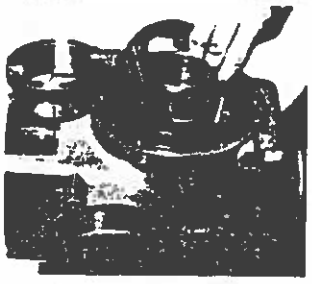
9 14A-95A actuators

14A - 95A actuators

Check that the clutch finger is lying lengthways on wormwheel. If in vertical raised position push lower end of finger sideways with screwdriver. Clutch spring will return finger to horizontal position.

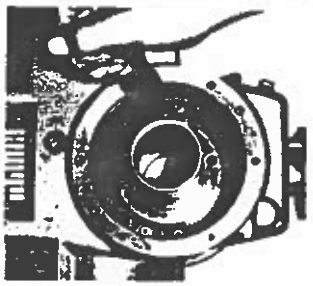
10 14A-19A actuators

To remove gearcase parts press down firmly on spring retaining washer maintain depressed and remove 'O' ring on output shaft. Take great care when releasing clutch spring. Take out clutch ring (and lower washer on 40A if fitted).



11 14A-19A actuators

Slide clutch ring up output shaft and remove. Lift out yoke assembly as shown, ie the finger must be held horizontally and the yoke brought out end first.



12 14A - 95A actuators

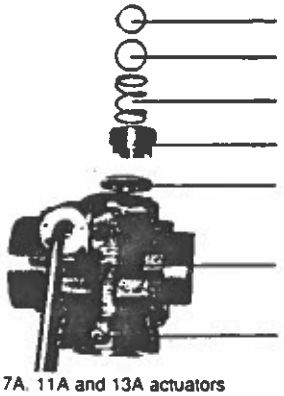
Unscrew capscrews retaining thrust pad and remove pad.

Remove wormwheel.

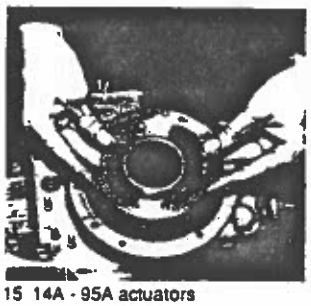
13 7A, 11A and 13A actuators

7A, 11A and 13A actuators
To remove wormwheel

Disconnect and slide out motor.
Remove clutch retaining circlip, clutch washer and clutch spring from top of center column.
Withdraw clutch ring, avoiding dropping clutch keys into gearcase sump.
Locate hand-auto jack assembly resting on the wormwheel. Push the finger spring off the wormwheel. Lift out the wormwheel.



14 7A, 11A and 13A actuators

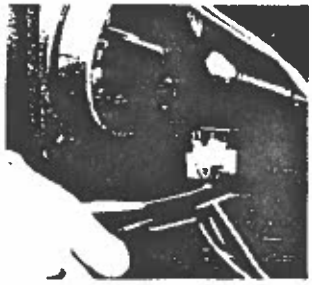


15 14A - 95A actuators

Replacement

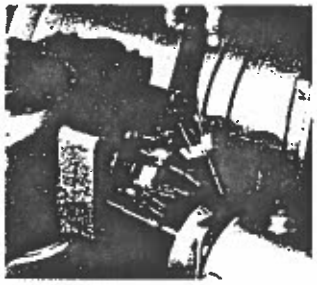
Slide replacement wormwheel down output shaft, ensuring that surfaces are clean and drive dogs are uppermost. Ensure the free rotation of the wormwheel on the centre column both before and after installation of the thrust pad.

Replace thrust pad and tighten capscrew diagonally. Ensure free rotation of wormwheel.



16 All actuators

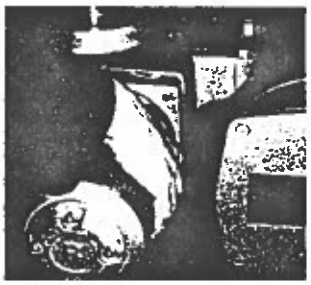
Slide identification tags on replacement motor assembly up to black sheath. Cut motor and thermostat leads approximately 6" from stator.



17 All actuators

Butt connect the leads from the terminal compartment to those of the new motor.

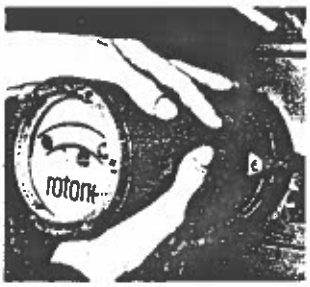
Verify carefully the proper match-up of leads.



18 All actuators

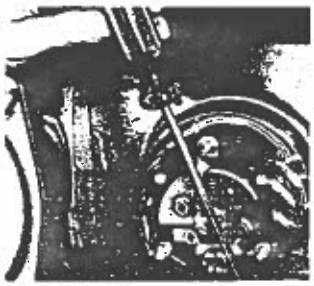
Install the motor assembly in the gearcase. Take care not to damage the gearcase oil seals with the wormshaft threads. Guide any excess motor leads towards terminal compartment and press motor assembly into the gearcase.

Ensure that the letter 'R' on motor end cap (except on 7A, 11A and 13A actuators) is correctly positioned before replacing motor cover capscrews/washers.



19 All actuators

Remove 3 capscrews and pull off switch mechanism cover squarely.



20 All actuators

Check that torque adjusting frontplate is vertical by observing the match-up pointers on the switch mechanism frame and the torque adjusting front plate.

Do not remove the torque adjusting frontplate from its position on its operating shaft.

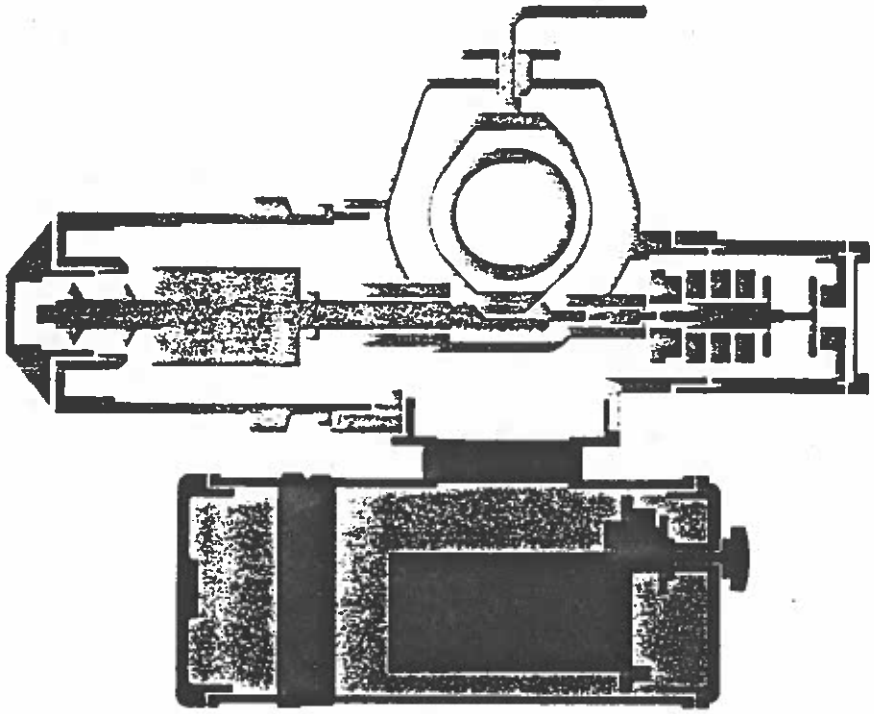
This is a factory set position and requires special equipment to re-set if disturbed.

rotork actuation

Maintenance and spare parts manual
Sub-assembly 6
Syncropak starter

for A Range Actuators type 1200 and 1400 series

Catalog section 5
Publication number AE5/4.6
Date of issue 3/90



Syncropak starter sub-assembly comprises a reversing starter or motor controller, control transformer, indicating lamp, local control station and separate terminal compartment. The starter and chassis and the control transformer are available separately. However, we recommend for reasons of simplicity and ease of quality assurance, that the complete sub-assembly is changed out in the field. The cover with the local push button control station is also available.

A spare control fuse is housed behind the cover with the push buttons.

Standard optional extras, such as interposing relays, phase discriminator, etc., can be mounted on a separate chassis inside the Syncropak sub-assembly. Please refer to sub-assembly 9.

Available parts

6a Syncropak starter and controls complete with housing.

6b Starter mounted on chassis.

6c Contactor Assembly. Pair of open/close contactors on base plate.

6d Transformer.

6f Syncropak cover complete with push button control station.

Parts available from other suppliers

6g Lamp:

General Electrical type 53 or TS53
Osram 12v/2.2W MBB

Fuses:

AGC 1/2 amp from Bussman Mfg Div, McGraw-Edison Co Belling Lee size 0 ref L1055/500

rotork actuation

UK head office
Rotork Controls Limited
telephone Bath (0225) 428451
telefax (0225) 333467

USA head office
Rotork Controls Inc
telephone Rochester (716) 3281550
telefax (716) 3295848

	telephone	*telefax*
Australia, Ballarat	(53) 381566	(53) 381570
Australia, Brisbane	(617) 2946139	(617) 2946082
Australia, Perth	(434) 3533	(434) 3533
Australia, Sydney	(612) 9975039	(612) 9975057
Canada, Calgary	(403) 569 9455	(403) 569 9414
Canada, Edmonton	(403) 438 4042	(403) 449 6578
Canada, Montreal	(514) 355 3003	(514) 355 0024
Canada, Sarnia	(519) 337 9190	(519) 337 0017
Canada, Toronto	(416) 602 5665	(416) 602 5669
France, Paris	(1) 48 35 44 99	(1) 48 35 42 54
Germany, Leiden	(02103) 54098	(02103) 54090
India, Madras	(44) 652294	(44) 6257108
Italy, Milan	(02) 8241001	(02) 89200301
Malaysia, Kuala Lumpur	(3) 2446418	(3) 2446416
Netherlands, Rotterdam	(010) 414 6911	(010) 4144750

	telephone	*telefax*
Saudi Arabia, Al Khobar	(03) 8579956	(03) 8577170
Singapore	(65) 4571233	(65) 4576011
South Korea, Seoul	(02) 565 4803	(02) 565 4802
Spain, Vizcaya	(94) 676 4244	(94) 676 4864
USA, Chicago	815 436 1710	815 436 1789
USA, Houston	713 782 6888	713 782 8524
USA, New York City	201 646 9596	201 646 9288
USA, Philadelphia	215 696 7302	215 696 7354
Venezuela, Caracas	582 323536	582 326412

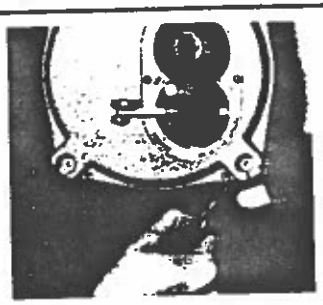
Sub-assembly 6

1 Part 6a

Dismantling Actutators type 1200 and 1400 series FLP (BS229)/ FM/WT enclosure.

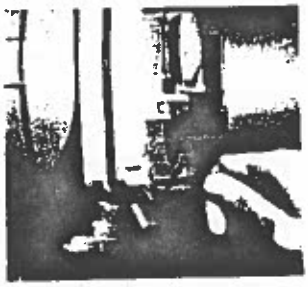
Isolate incoming electrical supply to actuator.

Remove terminal box cover by unscrewing 4 retaining screws and pulling off cover. If actuator fitted with explosionproof/watertight cover, use two screws in jacking holes. Disconnect and remove external wiring from housing.



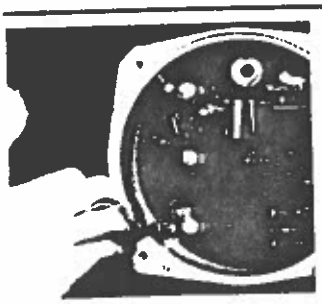
2 Parts 6a, b, d, f, g.

Break Quality Control seal on starter cover.



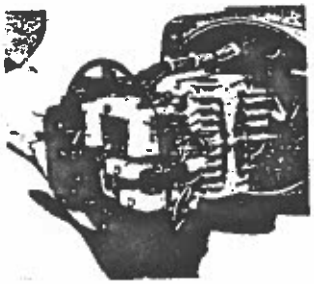
3 Parts 6a, b, d, f, g.

Unscrew the 4 cover capscrews and remove cover. If necessary use two capscrews in threaded jacking holes in cover. Do not use a screw-driver which can damage 'O' ring seal.



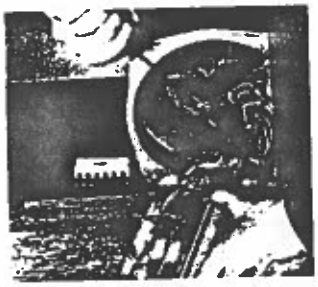
4 Parts 6a, b

Remove rubber clamping strip, if fitted, and unscrew 3 frontplate retaining screws.



5 Parts 6a, b

Withdraw starter chassis and let it hang naturally from its restraint strap.



6 Part 6a

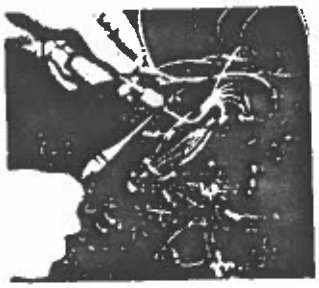
Actuators with separate motor terminal block

Turn chassis over to see if motor terminal block fitted, if so remove cover and disconnect leads from block. As an extra check for use on reconnection, sketch out terminations.

7 Part 6a

Actuators without separate motor terminal block

If terminal block is not fitted pull off motor leads from side of contactor block and note terminations.

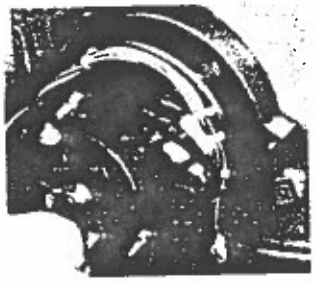


8 Part 6a

Separate connectors on thermostat leads 5 and 55 in housing.

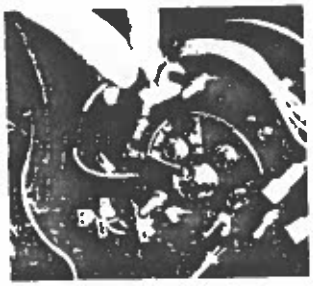
9 Part 6a

Remove 3 retaining screws and pull off indicator cover squarely.



10 Part 6a

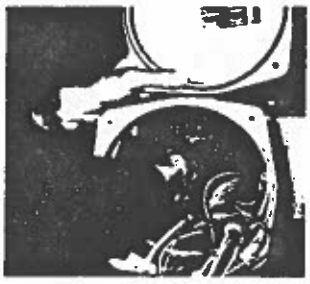
Disconnect leads from switches.



11 Part 6a

Separate lamp assembly from switch mechanism.

Sub-assembly 6

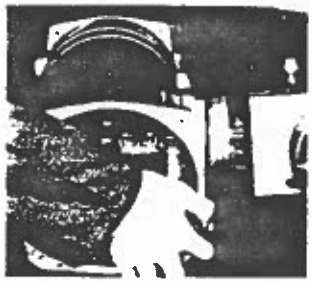


12 Part 6a

If Add-on-Pak 1 fitted do not remove lamp assembly or switch leads from Add-on-Pak 1. Check terminal number on wiring code card and disconnect Add-on-Pak 1 leads from back of terminal bushing. A flashlight may be useful.

13 Part 6a

If Add-on-Pak 1 is fitted trace lamp lead 'no. 60' through into starter housing and cut in convenient position for butt connecting later.



14 Part 6a

Using Allen wrench provided, remove 4 capscrews between Syncropak 2 housing and gearcase or gearcase adaptor. Separate housing from gearcase.

15 Part 6a

Unclip heater from bracket on switch mechanism back frame by sliding hand round through main gearcase.

16 part 6a

Dismantling Actuators type 1200 and 1400 series Cenelec enclosure

Using appropriate Allen wrench, undo 4 fixing capscrews between Syncropak housing and gearcase (or gearcase adaptor for sizes 40A - 95A). Separate housing from gearcase.

Noting connections, remove all FASTON connectors from the intermediate terminal bung.

Replace in reverse order with replacement/new module ensuring 'O' ring is in place and spigot greased.

17 Part 6a

Replacement Actuators type 1200 and 1400 series FLP (BS229)/ FM/WT enclosure

6a Syncropak starter complete with housing

Ensure that 'O' ring is in position on housing spigot before installing in the gearcase.

Place housing close to gearcase. Feed motor and thermostat leads and Add-on-Pak 1 leads, if fitted, through into housing. Feed switch leads, heater and lamp assembly through gearcase to switch mechanism.

Clip heater into bracket on mechanism backframe.

Ensure all leads move freely between switch mechanism and gearcase.

Hold leads in middle of spigot and mount replacement housing on gearcase. Replace 4 retaining screws and washers using key provided.

Connect leads and lamp assembly to switch mechanism. Replace indicator cover. If Add-on-Pak 1 fitted see 18.

18 Part 6a

If Add-on-Pak 1 fitted, butt connect lamp lead no. 60 in starter housing. Check Add-on-Pak 1 lead numbers on wiring code card and reconnect to back of bushing with aid of a flashlight.

Reconnect thermostat leads numbers 5 and 55 in housing. Refer to sketch of motor terminations and reconnect motor leads.

19 Part 6a

Replace starter chassis making sure that slide rails engage with channels in housing and that none of the wiring is pinched. Replace the 3 retaining screws and rubber spacer, if fitted.

Replace end cover and 4 retaining screws.

Qualified site personnel will crimp on Quality Control seal provided.

After reconnection of external wiring, refer to section 6 of Instruction Manual AE5/0 for electrical startup.

Before replacing terminal box cover check that wiring diagram on code card corresponds to actuator wiring and enter serial number on actuator nameplate on cover code card.

20 Part 6b

6b Syncropak starter and chassis

Follow dismantling instructions 2 to 5. The instructions for 6a cover the replacement of both chassis and wiring loom. If the original loom is undamaged, simply substitute for wiring on replacement starter. Using this method it is not necessary to disconnect external wiring or withdraw the terminal bushing from the housing.

21 Part 6b

Disconnect all wiring from existing chassis and remove screws securing wiring harness. Remove chassis from restraint strap and discard.

22 Part 6b

Offer up new chassis complete with harness and attach restraint strap for support. Remove screws securing harness to chassis

Working from left to right remove wires on new chassis one at a time and note the wire reference number.

Replace each wire with corresponding number on the existing harness. Repeat for all wires using the new harness as a key for numbering and wiring layout.

23 Part 6b

When harness is completely refitted discard excess harness and replace screws securing harness to chassis Replace motor wires on contactor and replace chassis in housing.

Replacement Actuators type 1200 and 1400 series Cenelec enclosure

If Cenelec enclosure - remove all connections between module 6b and the Cenelec intermediate bung and also the main terminal bung.

Locate and remove the black nylon restraint strap, located in the centre of the underside of steel chassis.

Re-fit

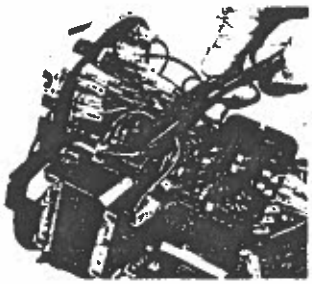
Slide out module 6b and replace with replacement/new module.

24 Part 6d

6d Transformer

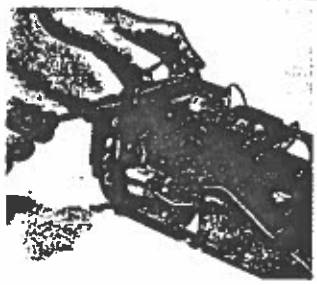
Isolate incoming electrical supply to actuator

Follow dismantling instructions 2 to 5.



25 Part 6d

Taking note of connections remove all FASTON connectors from the transformer.



26 Part 6d

Locate and remove 4 fixing screws securing transformer to chassis.

Slide out transformer - replace in reverse order with replacement/new module.

27 Part 6d

Note: Older type transformers have flying lead connections and can only be fitted if the chassis assembly has a nylon front-plate. Later transformers have a top mounted terminal block and can be fitted to either nylon or metal front-plate versions.

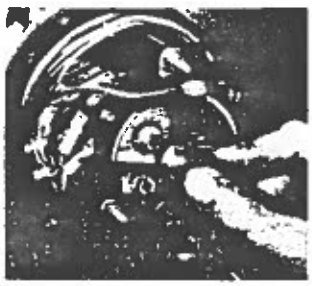
28 Part 6d

Replace starter chassis making sure that slide rails engage with channels in housing. Make sure none of the wiring harness is pinched. Replace 3 retaining screws.

Replace starter cover and 4 retaining screws.

After reconnection of external wiring, refer to Section 6 of Instruction Manual AE5/0 for Electrical Startup.

Before replacing Terminal Box Cover check that wiring diagram on code card corresponds to actuator wiring and enter serial number on actuator nameplate on Cover Code Card.



29 Part 6g

6g Indicator lamp and fuses

To replace indicator lamp remove 3 retaining screws and pull off cover squarely.

Follow dismantling instruction 9 above and replace lamp.

Ensure that gearcase spigot is dirt-free and that the 'O' ring seal is in position before replacing cover.

30 Part 6g

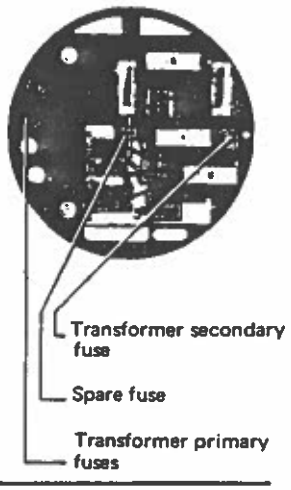
Fuses

Follow dismantling instructions 2 and 3 above.

Remove Syncropak cover with local control station.

All actuators are supplied with spare fuses.

31 Metal frontplate (showing location of switches and fuses)

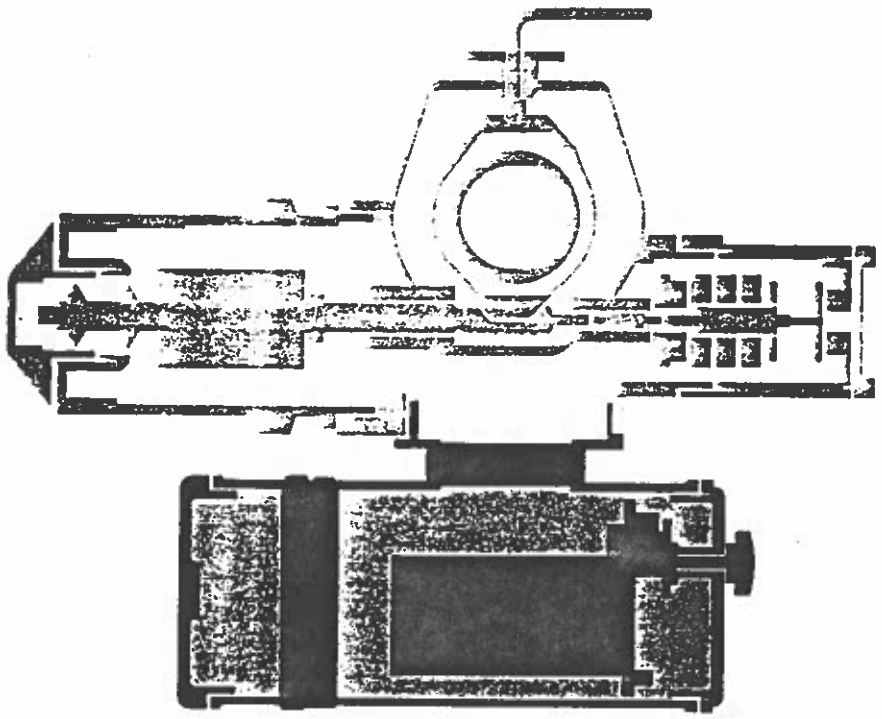


rotork actuation

Maintenance and spare parts manual

Sub-assembly 6 Syncropak starter for A Range actuators type 1600 series (Mk2 and 4)*

Catalogue section 5
Publication number AE5/4.6.1
Date of issue 12/92



The 1600 Series Mk 2 Syncropak starter sub-assembly comprises a reversing starter or motor controller, mounted onto an electronic printed circuit board with a control transformer, indicating lamp, local control station and a separate terminal compartment. The contactor, PCB and local control station are available separately. However, we recommend, for reasons of simplicity and ease of quality assurance, that the complete sub-assembly is changed out, in the field.

The 1600 Series Mk 4 Syncropak starter sub-assembly comprises a mounting chassis and frontplate onto which have been separately mounted a pair of reversing contactors, control transformer, primary and secondary fuses and printed circuit boards, which offer additional protection facilities and control options to those found in earlier marks.

Always quote actuator serial number when ordering spare parts.

* 1600 Series Mk2 can be recognised by the wiring diagram number stamped on the actuator nameplate label ie 1610-00 etc. 1600 Series Mk4 has the fifth character in the wiring diagram number as a letter - A or B eg. 1610A00

Available spares modules		MK2	MK4
6a/3	Complete Syncropak (castings and chassis)	■	■
6a/4	Complete Syncropak (castings and chassis) CENELEC enclosure	■	■
6b/3	Slide-in chassis complete with push buttons and PCB	■	
6b/4	Printed circuit board (PCB) and base plate	■	
6b/5	Startex chassis complete		■
6b/6	Main printed circuit board		■
6b/7	Remote control printed circuit board		■
6c/2	Contractors and baseplate	■	
6c/3	Contractors and baseplate		■
6d/2	Power module (transformer, fuses etc.)		■
6f/2	Push button cover	■	
6f/3	Push button cover		■
6f/4	Switches and loom for push button cover	■	■
6f/5	Push button cover (CENELEC enclosure)	■	■
6f/6	Red selector knob/dust shroud/nylon cam etc.	■	■
6f/7	Black local-remote selector knob/shaft/cam etc.	■	■

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Spares modules and fitting instructions for type 1600 series Mk2 actuators*

*1600 series actuators can be recognised by the wiring diagram number stamped on the nameplate i.e.. 1610-00 etc.

As many of the items below are available in various forms dependant on customers exact requirements, please discuss specifications with Rotork before purchase.

Safety note: Before commencing work on actuator, isolate incoming electrical supply and disconnect all incoming cables from the conduit entries.

Module 6a/3, 6a/4

CENELEC enclosure

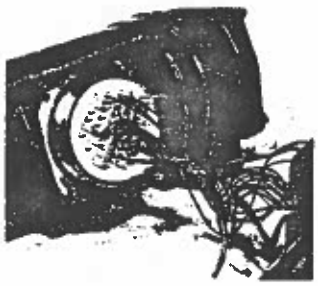
Complete Syncropak (castings and chassis)

Variable item dependant on enclosure, wiring diagram.

Note: photograph shows Cenelec enclosure with intermediate terminal bung. Models other than Cenelec ie WT, EP have no intermediate bung.

Removal

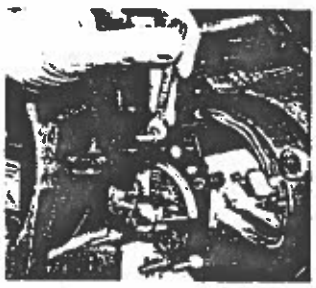
Using appropriate Allen key, remove 4 capscrews between Syncropak housing and gearcase (or gearcase adaptor in the case of 40A - 95A actuator sizes).Separate housing from gearcase.



Dependent on enclosure:

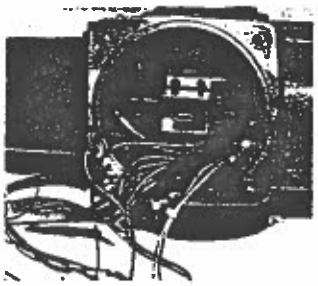
If as per photograph, Cenelec enclosure, remove all connections from gearcase side of intermediate terminal bung.

If non-Cenelec, remove switch mechanism cover (and AOP1 cover if fitted). Disconnect all cables to switch mechanism (and AOP1 if fitted) making a note of all connections.



Mechanically disconnect indicator lamp.

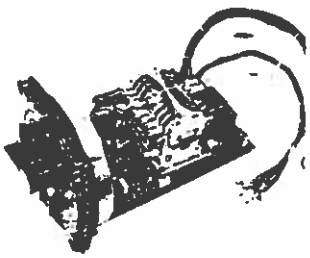
With Syncropak housing already separated from gearcase, disconnect motor cables from contactor (making note of connections).



Locate heater, remove fixing cap-heads. Remove Syncropak housing completely.

Re-fit

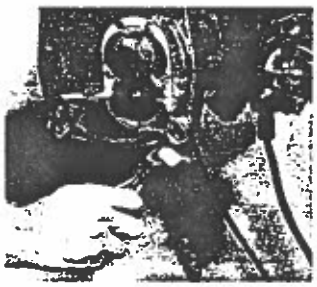
Replace in reverse order using replacement/new components.



Module 6b/3

Complete starter mounted on chassis

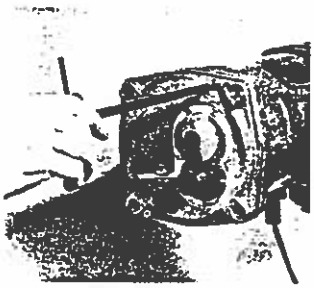
Syncropak chassis comprising printed circuit board, contactors, push-button station (and cable loom if required).



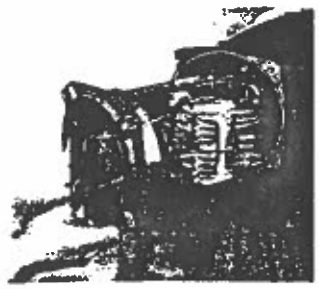
Variable, tailor-made item dependent on enclosure, wiring diagram.

Removal

Remove QC seal from push-button cover.



Remove 4 fixing screws securing push-button cover.



Slide out cover complete with chassis.

If Cenelec enclosure

Remove all connections between module 6b/1 and the Cenelec intermediate bung and also the main terminal bung.

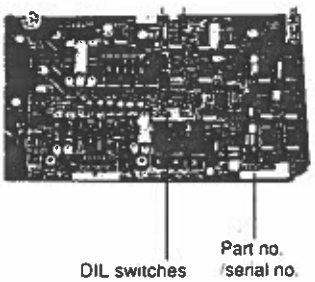
If Non-Cenelec enclosure (WT, FM):

Disconnect cables from module 6b/3 and the main terminal bung and disconnect plugs from sockets 2 and 3.

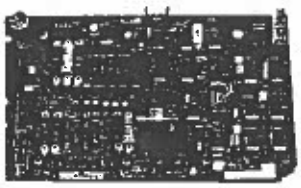
Locate and remove black nylon restraint strap located in centre of underside of steel chassis.

Re-fit

Slide out module 6b/3 and replace with replacement/new module ensuring 'O' ring is in place and spigot greased.



Note: Please ensure that DIL switches (marked 1 to 4 and located on the PCB) are switched to the same position as the previous replaced board.



Module 6b/4

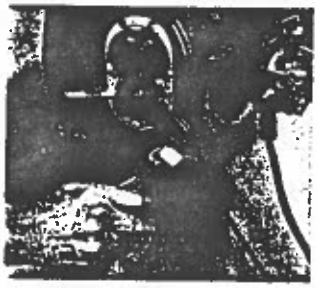
* Chassis comprising PCB and contactors only.

Syncropak chassis comprising printed circuit board and contactors only (without push-button station and chassis) - or chassis with printed circuit board only.

Variable item dependant on Wiring diagram

Safety note: *Please ensure that printed circuit board is always handled by its edges and that electronic components on the board are not touched by hand, to prevent possible injury by static discharge of components.*

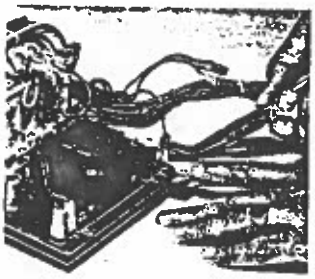
* **Important:** Two versions of the PCB are used: one without timer and one with timer. Check that the first five digits of the Part number on the new PCB correspond to those of the original unit (e.g. 26229-xxx)



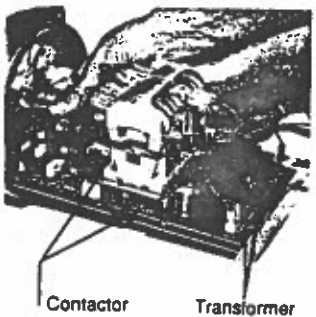
Removal

Remove QC seal from the push-button cover.

Remove 4 fixing screws securing push-button cover and slide out cover complete with chassis.



Disconnect all incoming cables to module 6b/4 (noting all connections).



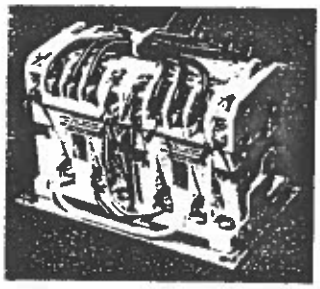
Disconnect push-button cable loom from socket 1 located on the front end of the printed circuit board. Remove 4 fixing screws from contactor baseplate and remove contactor.

Undo 4 screws that secure transformer to baseplate.

Locate nylon printed circuit board pillar fixing studs (x2) at front end of PCB and remove board from pillars.

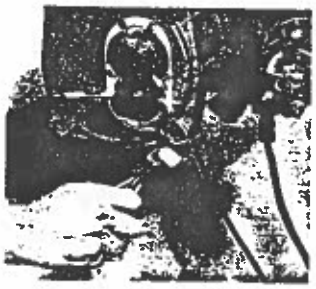
Re-fit

Replace in reverse order with replacement/new module ensuring 'O' ring is in place and spigot greased.



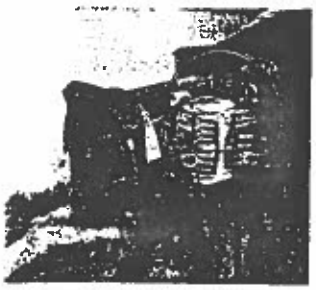
Module 6c/2

Pair of pre-wired contactors mounted on baseplate

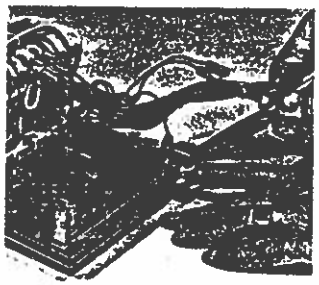


Removal

Remove QC seal from the push-button cover.



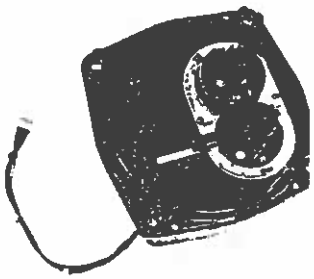
Remove 4 fixing screws securing push-button cover and slide out cover complete with chassis.



Noting their position, remove all FASTON connections from the contactor. Locate and remove 4 fixing screws securing baseplate to chassis.

Re-fit

Replace in reverse order with replacement/new module.

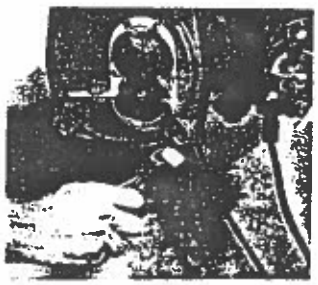


Module 6f/2, 6f/5

CENELEC enclosure

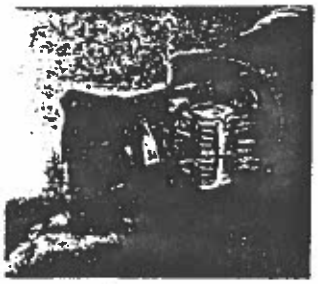
Syncropak cover with push-button station and loom

Variable item dependant on: Enclosure.



Removal

Remove QC seal from the push-button cover.



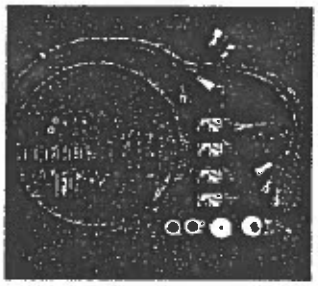
Remove 4 fixing screws securing push-button cover and slide out cover complete with chassis.

Disconnect plug from socket 1 (located at the push-button end of the PCB).

Locate and remove 2 capscrews securing steel chassis to push-button cover.

Re-fit

Replace in reverse order with replacement/new module ensuring 'O' ring is in place and spigot greased.



Module 6f/4

Syncropak cover spares list

Comprising:
Switches
Springs
Screws and Spacers
Loom
'O' Ring Seal
Cams

Module 6f/6

Syncropak cover, red selector knob

Comprising:
Knob and control spindle
Cams
Dust shroud
Springs, washers and seal

Module 6f/7

Syncropak cover, black local/remote selector knob

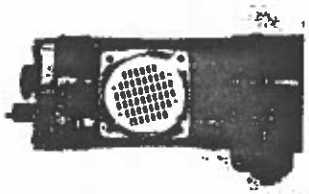
Comprising:
Knob and control spindle
Cam
Springs, washers and seal

Spares modules and fitting instructions for type 1600 series Mk4 actuators*

* 1600 series Mk4 actuators can be recognised by the fact that the fifth character in the wiring diagram number is a letter - A or B (i.e. 1610 A00)

As many of the items below are available in various forms dependant on customers exact requirements - please discuss specification with Rotork before purchase.

Safety note: Before commencing work on actuator, isolate incoming electrical supply and disconnect all incoming cables from the conduit entries.



Module 6a/3, 6a/4

CENELEC enclosure

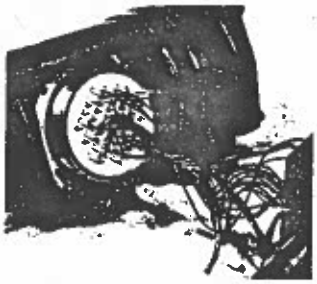
Complete Syncropak (castings and chassis)

Variable item dependant on: Enclosure, Wiring Diagram

Note: Photograph shows Cenelec enclosure with intermediate terminal bung - models other than Cenelec i.e. WT, EP have no intermediate bung.

Removal

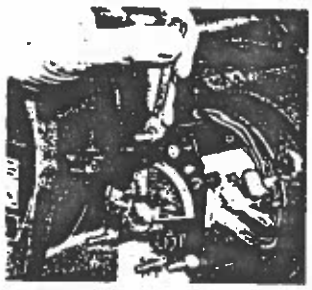
Using appropriate Allen key, remove 4 capscrews between Syncropak housing and gearcase (or gearcase adaptor in the case of 40A - 95A actuator sizes). Separate housing from gearcase.



Dependent on enclosure:

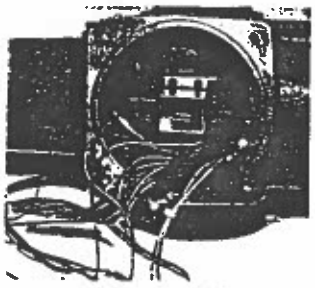
If as per photograph, Cenelec enclosure, remove all connections from gearcase side of intermediate terminal bung.

If non-Cenelec, remove switch mechanism cover (and AOP1 cover if fitted). Disconnect all cables to switch mechanism (and AOP1 if fitted) making a note of all connections.



Mechanically disconnect indicator lamp.

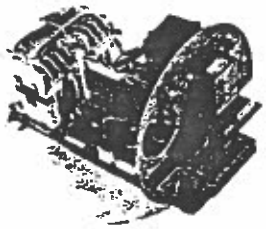
With Syncropak housing already separated from gearcase, disconnect motor cables from contactor (making note of connections).



Locate heater, remove fixing cap-heads. Remove Syncropak housing completely.

Re-fit

Replace in reverse order using replacement/new components.

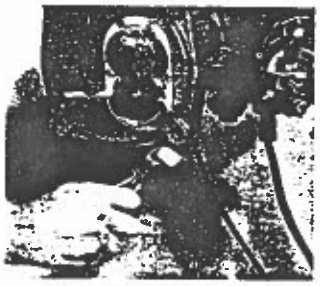


Module 6b/5

Complete starter mounted on chassis

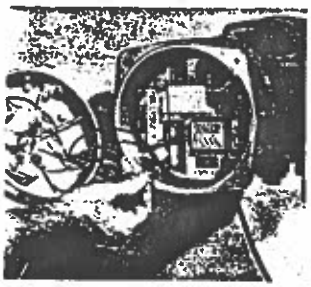
Syncropak chassis, comprising two printed circuit boards, contactors, transformer and fuseholders.

Variable item dependant on: Wiring Diagram.

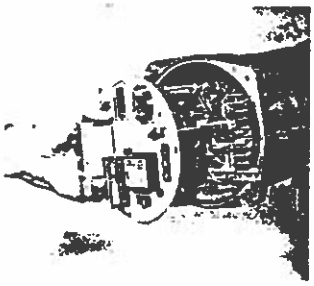


Removal

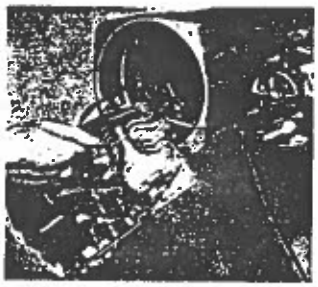
Remove QC seal from push-button cover. Remove 4 fixing screws securing push-button cover.



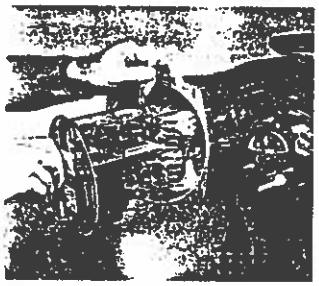
Remove cover, and disconnect push-button cable loom from printed circuit board. Disconnect black nylon restraint strap from chassis.



Locate and remove 3 caphead screws securing chassis to Syncropak housing - slide out chassis.



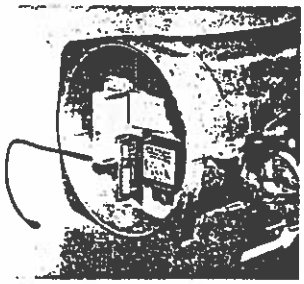
Taking note of connections, disconnect all FASTON connectors from the contactors. Disconnect all plugs and sockets on the 2 printed circuit boards.



Locate and disconnect screw securing chassis restraint strap.

Locate and remove Earth (Ground) bonding link from chassis.

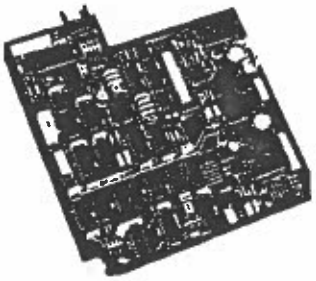
Chassis can now be removed.



Re-fit

Note: On replacement unit-check position of DIL switches and ensure they are set as per original module.

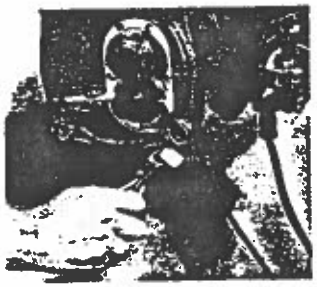
Replace in reverse order with replacement/new module, ensuring 'O' ring is in place and spigot greased.



Module 6b/6

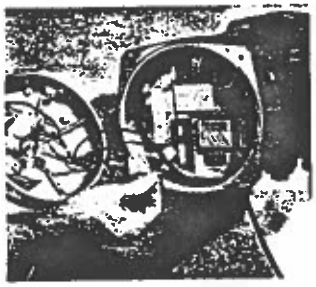
Main Mk4 PCB only

Safety note: Please ensure that printed circuit board is always handled by its edges and that electronic components on the board are not touched by hand, to prevent possible injury by static discharge of components.

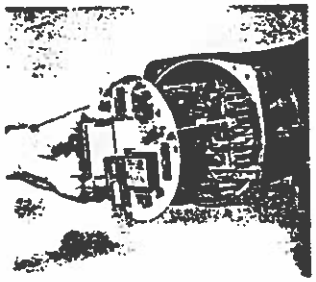


Removal

Remove QC seal from push-button cover. Remove 4 fixing screws securing push-button cover.

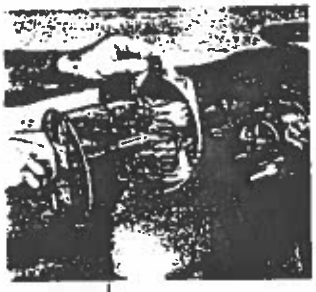


Remove cover, and disconnect push-button cable loom from printed circuit board. Disconnect black nylon restraint strap from chassis.



Locate and remove 3 caphead screws securing chassis to Syncropak housing - slide out chassis.

Remove all plug and socket connections from both printed circuit boards.



Remote control board

Remove remote control board by locating and removing securing screw on chassis frontplate holding white nylon block in position.

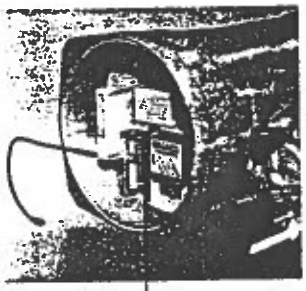
Locate and cut through white nylon strap securing board to white nylon vertical support.

Unplug and slide out remote control board.

Locate 4 white nylon pillar fixing studs and remove main printed circuit board from chassis.

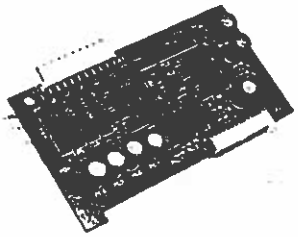
Re-fit

Replace in reverse order with replacement/new module ensuring 'O' ring is in place and spigot greased.



DIL switches

Note: On replacement unit, check position of DIL switches and ensure they are set as per original module.



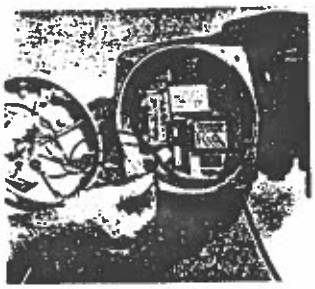
Module 6b/7

Remote control PCB only

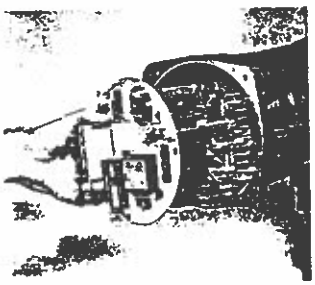
Variable item dependant on Wiring diagram **Safety note:** Please ensure that printed circuit board is always handled by its edges and that electronic components on the board are not touched by hand, to prevent possible injury by static discharge of components.

Removal

Remove QC seal from push-button cover. Remove 4 fixing screws securing push-button cover.



Remove cover, and disconnect push-button cable loom from printed circuit board. Disconnect black nylon restraint strap from chassis.



Locate and remove 3 caphead screws securing chassis to Syncropak housing - slide out chassis.

Remove all plug and socket connections from both printed circuit boards.

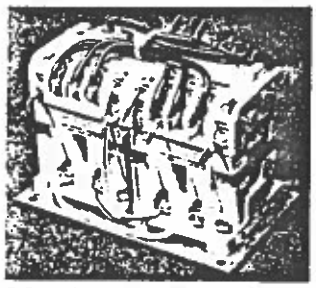
Remove remote control board by locating and removing securing screw on chassis frontplate holding white nylon block in position.

Locate and cut through white nylon strap securing board to white nylon vertical support.

Unplug and slide out remote control board.

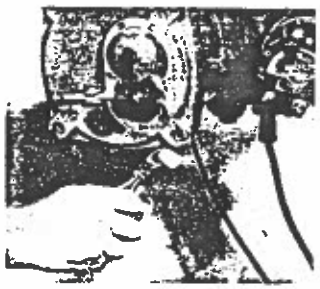
Re-fit

Replace in reverse order with replacement/new module ensuring 'O' ring is in place and spigot greased.



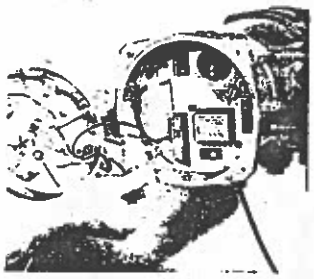
Module 6c/3

Pair of pre-wired contactors mounted on baseplate

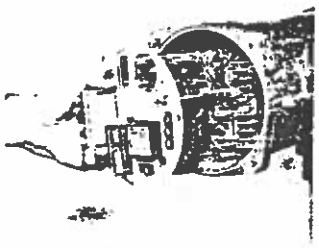


Removal

Remove QC seal from push-button cover. Remove 4 fixing screws securing push-button cover.



Remove cover, and disconnect push-button cable loom from printed circuit board. Disconnect black nylon restraint strap from chassis.



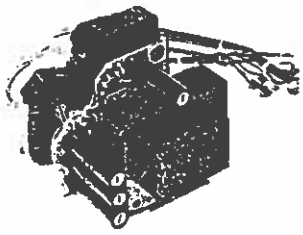
Locate and remove 3 caphead screws securing chassis to Syncropak housing - slide out chassis.

Contactor base plate fixing screws

Noting connections, remove all FASTON connectors on the contactor. Undo 4 fixing screws and remove contactor block from chassis.

Re-fit

Replace in reverse order with replacement new module ensuring 'O' ring is in place and spigot greased.

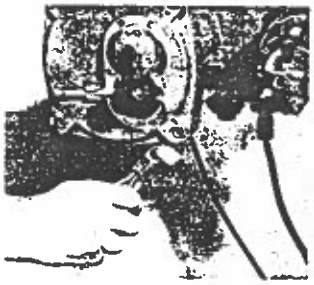


Module 6d/2

Power module

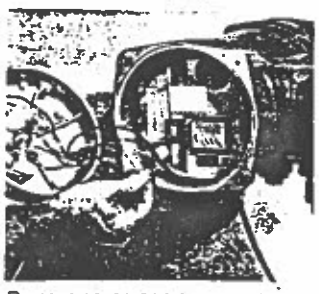
Transformer with primary and secondary fuses and cable loom

Variable item dependant on: 3 phase voltage.

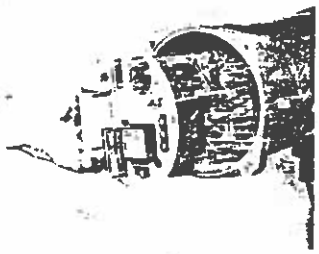


Removal

Remove QC seal from push-button cover. Remove 4 fixing screws securing push-button cover.



Remove cover, and disconnect push-button cable loom from printed circuit board. Disconnect black nylon restraint strap from chassis.



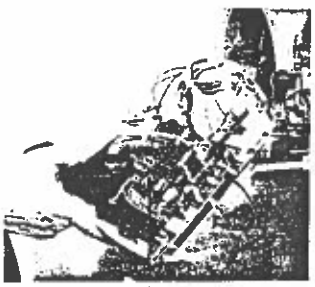
Locate and remove 3 caphead screws securing chassis to Syncropak housing - slide out chassis.

Locate cable loom coming from transformer - (making note of connections) - remove all FASTON connectors and plugs from PCB.

Locate 2 transformer fixing screws on front of chassis and remove.

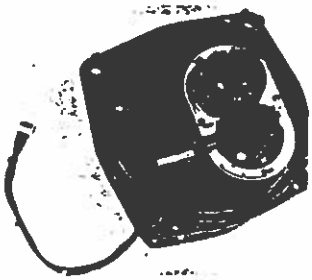
Re-fit

Replace in reverse order with replacement/new module ensuring 'O' ring is in place and spigot greased.



Voltage tapping

Note: Voltage tapping - Check position of voltage tapping plug is selected as per replaced item.



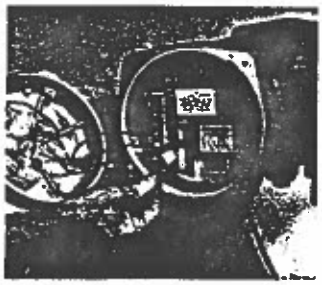
Module 6f/3, 6f/5

CENELEC enclosure

Syncropak cover with push-button station and loom.

Removal

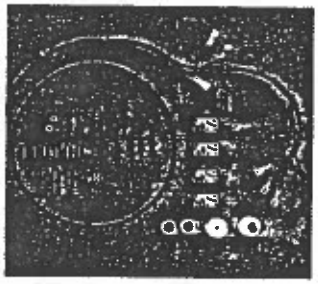
Remove QC seal from push-button cover. Remove 4 fixing screws securing push-button cover.



Remove cover, and disconnect push-button cable loom from printed circuit board. Disconnect black nylon restraint strap from chassis.

Re-fit

Replace in reverse order with replacement/new module, ensuring 'O' ring is in position and spigots greased.



Module 6f/4

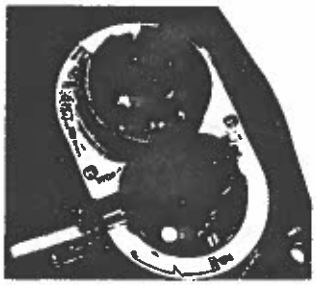
Syncropak cover spares kit

Comprising:
Switches
Springs
Screws and Spacers
Loom
'O' Ring Seal
Cams

Module 6f/6

Syncropak cover, red selector knob

Comprising:
Knobs and control spindle
Cams
Dust shroud
Springs, washers and seal



Module 6f/7

Syncropak cover, black local/remote selector knob

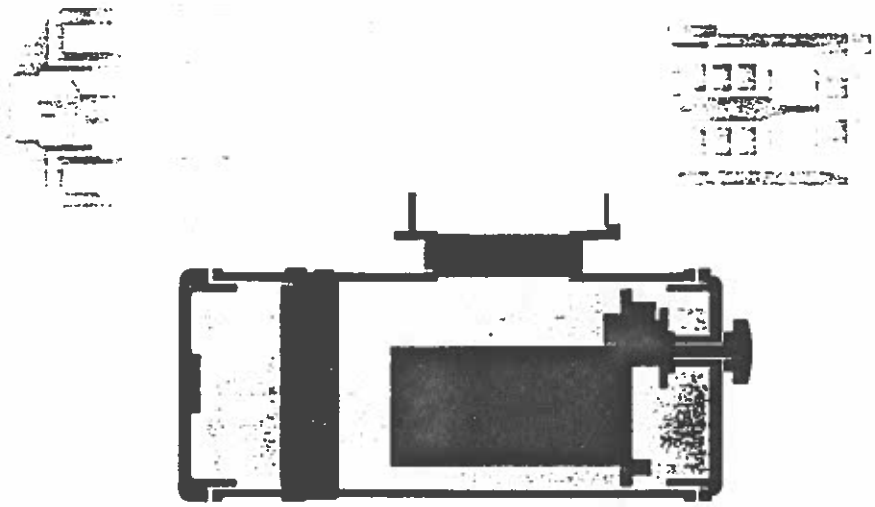
Comprising:
Knob and control spindle
Cam
Springs, washers and seal

rotork actuation

Maintenance and spare parts manual

Sub-assembly 6 Syncropak starter for A Range actuators type 1600 series Mk5

Publication number AE/4. 6.2
Date of issue 04/94



The 1600 Series Mk5 Syncropak starter sub-assembly comprisies a mounting chassis and frontplate onto which have been separately mounted a pair of reversing contactors, control transformer, primary and secondary fuses and printed circuit board, which offer additional protection facilities and control options to those found in earlier marks.

Always quote actuator serial number when ordering spare parts.

* 1600 Series Mk5 can be recognised by the wiring diagram number stamped on the actuator nameplate label it will have an 'X' as the fifth character, e.g. 1610X00.

Module no.		Description
6a/3		Complete Syncropak (castings and chassis) UNC*
6a/4		Complete Syncropak (castings and chassis) Cenelec enclosure*
6a/6		Complete Syncropak (castings and chassis) watertight metric*
6b/5		Starter chassis*
6b/6		Main printed circuit board*
6c/3		Contactors and base plate*
6d/2		Power module (Transformer and fuses)*
6f/3		Push button cover (UNC)
6f/4		Switches and loom for push button cover
6f/5		Push button cover (Cenelec and watertight metric)
6f/6		Red selector knob/dust shroud/nylon cam etc.*
6f/7		Black local-remote selector knob/shaft/cam etc*
6g/1		Folomatic PCB
6g/2		Combined folomatic and current position transmitter PCB
8g/3		Pakscan PCB*
6g/4		Interrupter timer PCB

*Variable item

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Australia Brisbane	(7) 2946139	(7) 2946082
Australia Perth	(434) 3533	(434) 3760
Australia Sydney	(2) 9975039	(2) 9975057
Canada Calgary	(403) 569 9455	(403) 569 9414
Canada Edmonton	(403) 438 4042	(403) 449 6578
Canada Montreal	(514) 355 3003	(514) 355 0024
Canada Sarnia	(519) 337 9190	(519) 337 0017
Canada Toronto	(905) 602 5665	(905) 602 5669
France Paris	(1) 48 35 44 99	(1) 48 35 42 54
Germany Hilden	(2103) 54098	(2103) 54090
India Madras	(44) 6257107	(44) 6257108
Italy, Milano	(2) 8241001	(2) 8920030
Malaysia, Kuala Lumpar	(3) 2446418	(3) 2446416

	telephone	*telefax*
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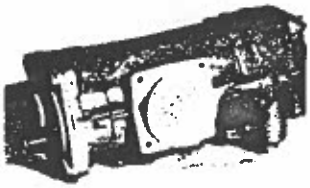
Saudi Arabia Al Khobar	(3) 8579956	(3) 8577170
Singapore	4571233	4576011
South Korea, Seoul	(02) 565 4803	(02) 565 4802
Spain Vizcaya	(4) 676 4244	(4) 676 4864
USA Chicago	(815) 436 1710	(815) 436 1789
USA Houston	(713) 782 5888	(713) 782 8524
USA New York City	(201) 646 9596	(201) 646 9288
USA Philadelphia	(215) 696 7302	(215) 696 7354
Venezuela Caracas	2 323536	t4 250822

Spares modules and fitting instructions for type 1600 series Mk5 actuators

1600 MK5 actuators can be recognised by the wiring diagram number stamped on the name plate, it will have an 'X' as the fifth character, ie 1610X00.

As many of the items below are available in various forms dependant on specification, always state actuator serial number when enquiring about or ordering spare parts.

Safety Note: Before commencing work on the actuator ensure that all incoming power supplies are isolated.



1 This is a variable item dependant on its enclosure and wiring diagram. Photograph shows mod.6a/4.(Cenelec) with intermediate terminal bung, enclosures other than Cenelec do not have this fitted.

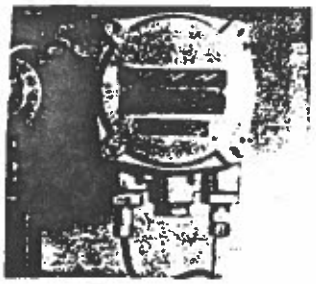
Module 6a/3

WT, FLP, FM & CSA enclosures (UNC screws)

6a/4 Cenelec enclosure

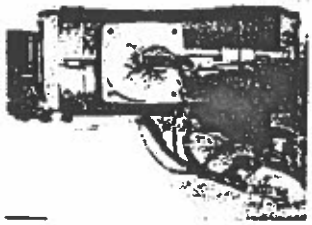
6a/6 WT (metric screws)

Complete Syncropak (Castings and chassis)

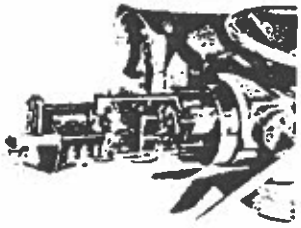


2 REMOVAL OF CASTING COMPLETE
Before dismantling the actuator disconnect incoming electrical cables, remove and retain any adaptors/reducers from the threaded cable entries.

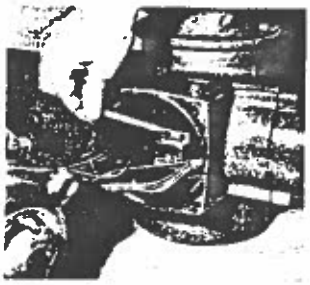
3 Using an appropriate size Allen key remove the four capscrews between syncropak body and gearcase (or gearcase adaptor in the case of size 40A to 95A). Separate body from gearcase.



4 ELECTPICALLY DISCONNECT SYNCROPAK (CENELEC)
Dependant on enclosure, if as per photograph (Cenelec enclosure), remove all connections from gearcase side of intermediate terminal bung, ensure that all cables are marked correctly for re-assembly.



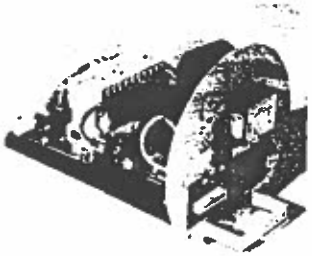
5 IF NON CENELEC
If non Cenelec, remove switch mechanism cover (and AOP1 cover if fitted). Disconnect all cables to switch mechanism (and AOP1 if fitted) making a note of all connections. Mechanically disconnect indicator lamp. With Syncropak housing already separated from gearcase disconnect motor cables from contactor (making note of connections). Also the two thermostat cables.



6 REMOVE HEATER (NON CENELEC ONLY)
Locate, remove and retain the two cap head screws securing the heater bracket. Syncropak can now be removed.

Re-fit

Reassemble in reverse order using the replacement component.

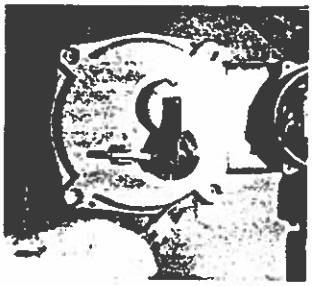


Module 6b/5

Complete starter mounted on chassis

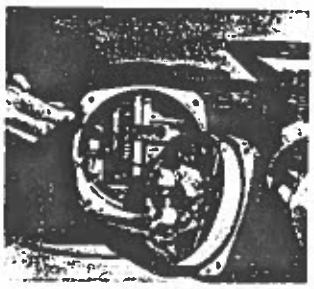
Syncropak chassis, comprising two printed circuit boards, contactors, transformer and fuseholders.

Variable item dependant on:
Wiring diagram.

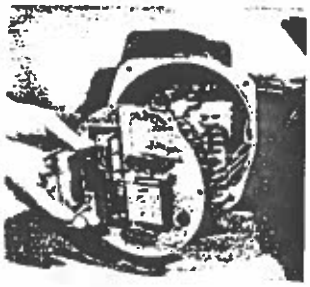


Removal

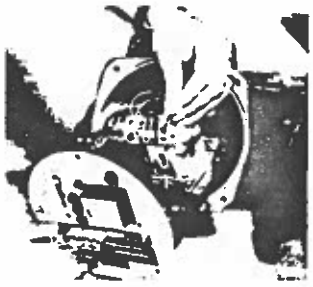
1 Remove QC seal from push-button cover. Remove 4 fixing screws securing push-button cover.



2 Remove cover, and disconnect push-button cable loom from printed circuit board. Disconnect black nylon restraint strap from chassis.

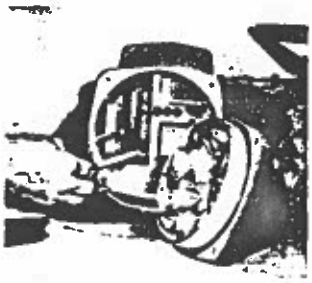


3 Locate and remove 3 caphead screws securing chassis to Syncropak housing - slide out chassis.

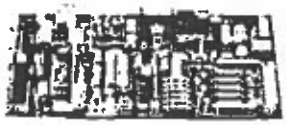


4 Taking note of connections, disconnect all FASTON connectors from the contactors. Disconnect all plugs and sockets on the printed circuit boards.

5 Locate and disconnect screw securing chassis restraint strap. Locate and remove Earth (Ground) bonding link from chassis. Chassis can now be removed.



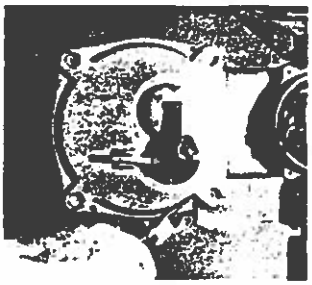
6 **Re-fit** Note: On replacement unit-check position of DIL switches and ensure they are set as per original module. Replace in reverse order with replacement/ new module, ensuring 'O' ring is in place and spigot greased.



Module 6b/6

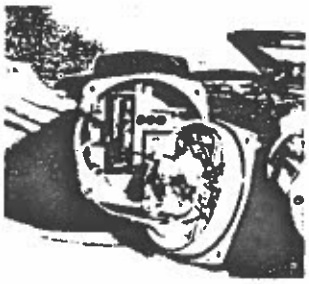
Main Mk5 PCB

Safety note: Please ensure that printed circuit board is always handled by its edges and that electronic components on the board are not touched by hand to prevent them being damaged by static discharge.

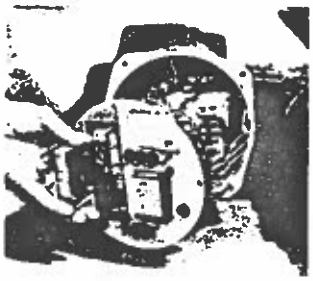


Removal

1 Remove QC seal from push-button cover. Remove 4 fixing screws securing push-button cover.



2 Remove cover, and disconnect push-button cable loom from printed circuit board. Disconnect black nylon restraint strap from chassis.

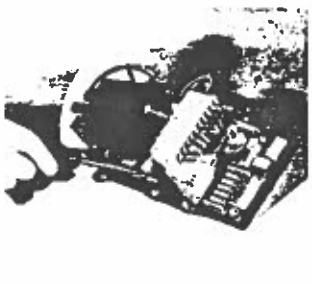


3 Locate and remove 3 caphead screws securing chassis to Syncropak housing - slide out chassis.

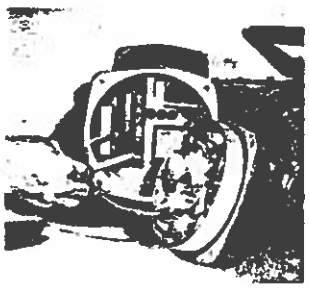
4 Remove all plug and socket connections from printed circuit boards.

5 REMOVE POWER MODULE
Locate, remove and retain the two caphead bolts and nuts securing the power module to the chassis, disconnect the three FASTON connectors going into the contactors taking note of their positions.

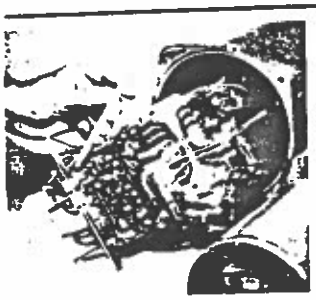
6 AUXILIARY PRINTED CIRCUIT BOARDS.
If the original main PCB has a second board fitted to it, (Folomatic - CPT or Pakscan) then this must be removed and refitted later.



7 MAIN PCB FIXING SCREWS
Locate, remove and retain the six screws securing the PCB. PCB can now be slid out from under the contactor bracket.

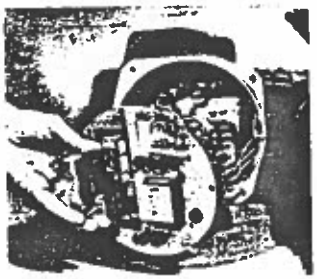


8 REFITTING
Before fitting the new PCB, check that the position of the switches situated at the front edge of the PCB are as the original unit.

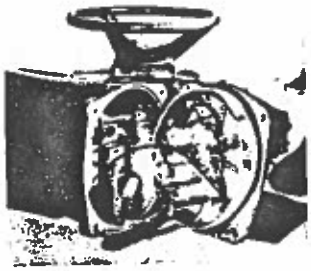


9 Slide the PCB into position and fix with 6 screws. If an auxiliary board was removed earlier (para 20) this must now be refitted.

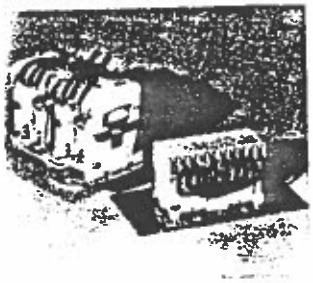
10 Refit the power module into its original position, reconnect all cables on PCB(s) and contactors.



11 Slide chassis assembly into the Syncropak casting and secure with 3 screws, re-attach black nylon restraint strap on the push-button cover.

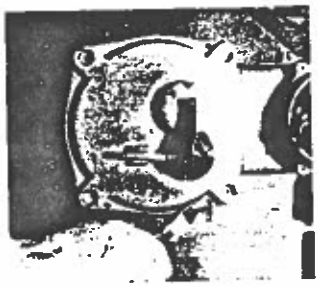


12 Before refitting push-button cover check that spigot and 'O' ring are in a serviceable condition, clean and lightly greased. Secure with 4 screws.



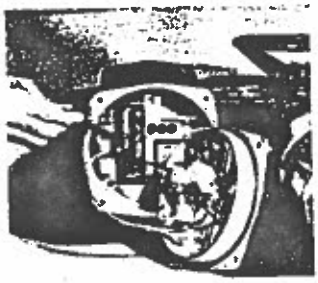
Module 6c/3

Consists of a pair of pre-wired contactors mounted on a steel base plate.

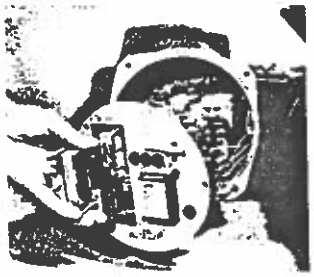


Removal

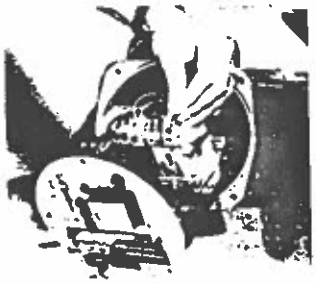
1 Remove QC seal from push-button cover. Remove 4 fixing screws securing push-button cover.



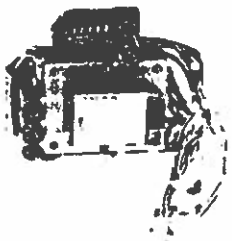
2 Remove cover, and disconnect push-button cable loom from printed circuit board. Disconnect black nylon restraint strap from chassis.



3 Locate and remove 3 caphead screws securing chassis to Syncropak housing - slide out chassis.

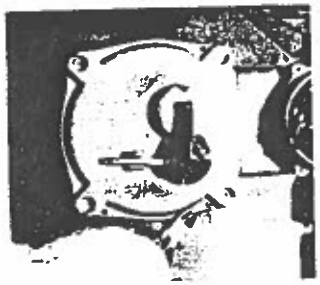


4 Contactor base plate fixing screws. Noting connections, remove all FASTON connectors on the contactor. Undo 4 fixing screws and remove contactor block from chassis. RE-FIT. Replace in reverse order with replacement/new module ensuring 'O' ring is in place and spigot greased.



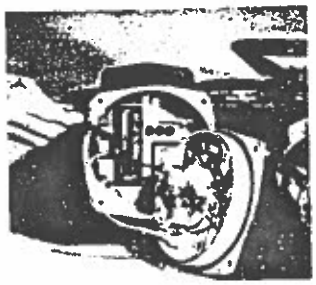
Module 6d/2

Power module. Transformer with primary and secondary fuses and cable loom. Variable item dependant on:3 phase voltage.

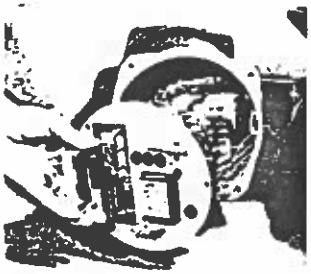


Removal

1 Remove QC seal from push-button cover. Remove 4 fixing screws securing push-button cover.

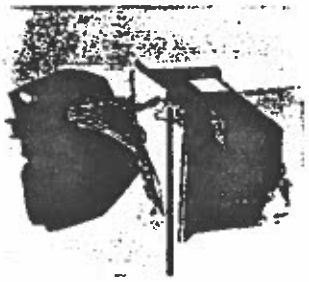


2 Remove cover and disconnect push-button cable loom from printed circuit board. Disconnect black nylon restraint strap from chassis.



3 Locate and remove 3 caphead screws securing chassis to Syncropak housing - slide out chassis. Locate cable loom coming from transformer - (making note of connections) - remove all FASTON connectors and plugs from PCB.

4 Locate 2 transformer fixing screws on front of chassis and remove. **Re-fit:** Replace in reverse order with replacement/new module ensuring 'O' ring is in place and spigot greased.



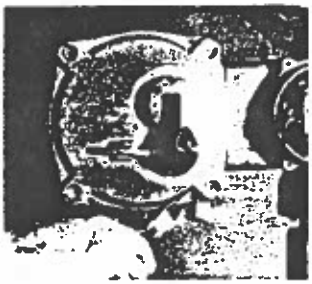
Voltage tapping

5 Note: Voltage tapping. Check position of voltage tapping plug is selected as per replaced item.

Module 6f/3

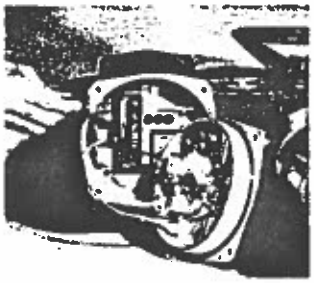
Push-button cover, switches and loom complete for enclosures. WT(UNC),FLP.FM.CSA.6F/5, for enclosures.WT(METRIC) Cenelec.

6f/5 for enclosures. WT (METRIC) Cenelec.



Removal

1 Remove QC seal from push-button cover. Remove 4 fixing screws securing push-button cover.



2 Remove cover and disconnect push-button cable loom from printed circuit board. Disconnect black nylon restraint strap from chassis.

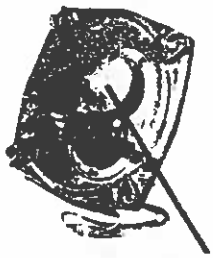
Refit

Refit in reverse order with replacement module, check that spigot and 'O' ring are in a serviceable condition, clean and lightly greased, secure with 4 new screws.

Module 6f/4

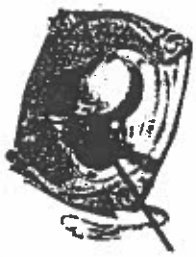
PUSH-BUTTON COVER SPARES KIT.

Comprises: Switches. Springs. Screws and Spacers. Loom. 'O' ring seal. Cam's.



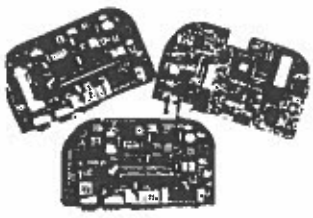
Module 6f/6

Push-button cover, red selector knob.
Comprising: Knob and control spindle. Cam's. Dust shroud. Springs, washers and 'O' ring seal.



Module 6f/7

Push-button cover, black local/remote selector lever.
Comprising: Lever and control spindle. Cam. Springs, washers and 'O' ring seal.



MODULES.

6g/1 Folomatic PCB.

6g/2 Folomatic and current position transmitter (CPT) PCB.

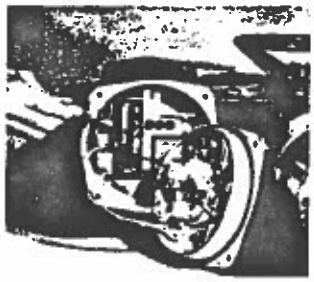
6g/3 Pakscan PCB

These three modules are optional extras and are fitting to the standard main PCB, however only one can be fitted at a time. These instructions apply to all three modules.

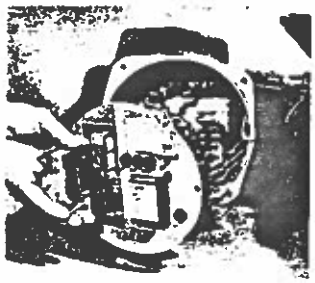
TYPICAL MODULE 6g

Removal

1 Remove QC seal from push-button cover. Remove 4 fixing screws securing push-button cover.



2 Remove cover, and disconnect push-button cable loom from printed circuit board. Disconnect black nylon restraint strap from chassis.



3 Locate and remove 3 caphead screws securing chassis to Syncropak housing - slide out chassis.

4 REMOVE POWER MODULE. Locate, remove and retain the two caphead bolts and nuts securing the power module to the chassis, disconnect the three FASTON connectors going into the contactors plus connections to main PCB taking note of their positions. Power module can be removed and retained for refitting later.

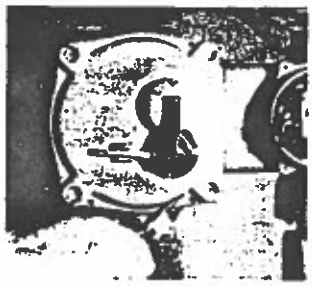
5 Disconnect all the plugs from the 6g PCB taking note of their positions. Remove and retain the two screws securing the PCB onto the main card. Locate the two white nylon stand-off pillars, depress the catch on each one and lift off the PCB.

REASSEMBLY.
6 Before fitting the replacement 6g PCB ensure that all DIL switches and mini plugs are positioned as on the original PCB. Refit in reverse order, before fitting push-button cover the Folomatic and/or current position transmitter must be recommissioned using Rotork publication E270E section 5.2. To be found at the back of this book.

Module 6g/4

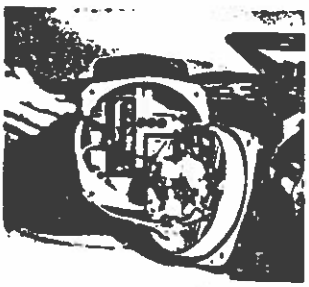
Interrupter Timer PCB

1 This PCB is an optional extra and is situated on the electrical chassis but on the reverse side to the main control PCB.

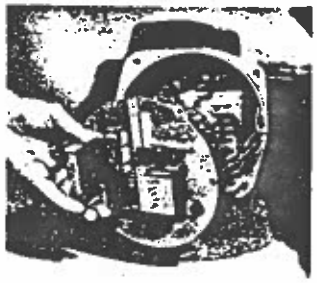


Removal

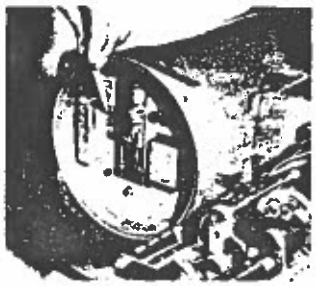
1 Remove QC seal from push-button cover. Remove 4 fixing screws securing push-button cover.



2 Remove cover and disconnect push-button cable loom from printed circuit board. Disconnect black nylon restraint straps from chassis.



3 Locate and remove 3 caphead screws securing chassis to Syncropak housing - slide out chassis.



4 Disconnect the electrical plug from the PCB, remove and retain the two screws securing the timer PCB onto the black plastic chassis.

5 Before fitting the replacement PCB ensure that the four DIL switches are positioned as on the original PCB.

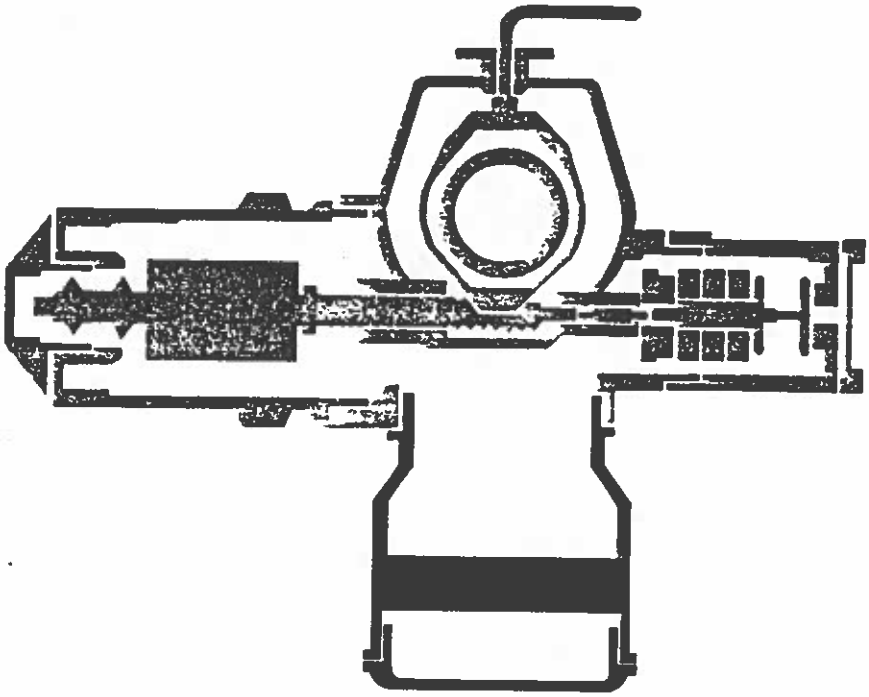
Refit in reverse order, before fitting the push-button cover the timer module must be recommissioned using publication E270E section 5.2. To be found at the back of this book.

rotork actuation

Maintenance and spare parts manual

Sub-assembly 7 SyncroSET housing for A Range Actuators

Catalog section 5
Publication number AE5/4.7
Date of issue 5/90



The current range of Rotork actuators are fitted with a separate terminal housing. Different types of terminal housing are designated;
EP or FM (explosionproof), to NEC Article 500
WT (watertight) to NEMA 6, IP68
WP (weatherproof) to NEMA 4, IP54
FLP (flameproof) to BASEEFA standards.
EExd (flameproof) to CENELEC Norm EN 500 14
EExd as EExd but with "increased safety" terminal box.

Syncroset actuators with push buttons are fitted with the housing used with Syncropak units; specify part 6f for replacement cover complete with local push button station.

The instructions are applicable to EP, WT and FP housings. WP housings can be replaced without difficulty.

Available parts

- **7a** SyncroSet FM/WT terminal housing.
- **7b** SyncroSet FP terminal housing.
- **7c** SyncroSet EP/WT/FP terminal housing cover.
- **7d** SyncroSet WP terminal housing.
- **7e** SyncroSet WP terminal housing cover.

rotork actuation

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Singapore	(65) 4571233	(65) 4576011
(South) Korea, Seoul	(02) 565 4803	(02) 565 4802
Spain, Vizcaya	(94) 676 4244	(94) 676 4864
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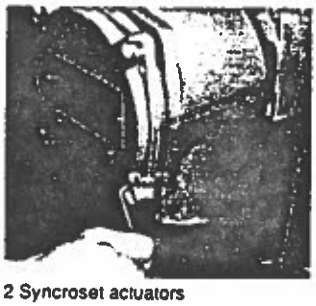
USA, New York City	(201) 646 9596	(201) 646 9288
Venezuela, Caracas	(2) 263 6533	(14) 250822

1 Syncroset actuators

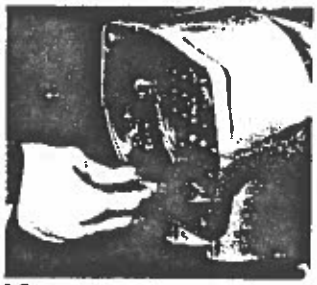
Dismantling

To replace either 7a, b or d isolate incoming electrical supply.



2 Syncroset actuators

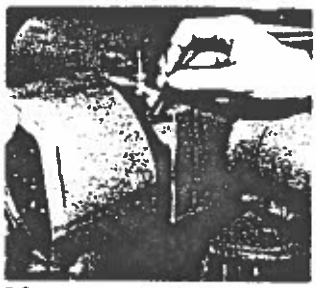
Unscrew 4 capscrews and remove terminal housing cover, using two screws in jacking holes provided to ease off cover where necessary.



3 Syncroset actuators

Disconnect and remove all external wiring. Remove the earth lug and the red plastic cover over heater terminal.

4 Syncroset actuators

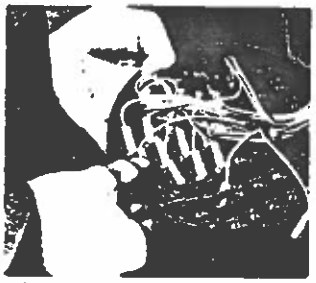


5 Syncroset actuators

Remove 4 capscrews between Syncroset terminal housing and gearcase adaptor. Separate housing from gearcase.

6 Syncroset actuators

Withdraw terminal bushing from housing by carefully tapping around edge of bushing inside housing with a wooden handle.



7 Syncroset actuators

As an extra check for reconnecting later, make a sketch of lead terminations. Disconnect motor thermostat, heater and switch leads from terminals.

8 Syncroset actuators

Replacement

Open replacement housing, as described above, and tap out terminal bushing.

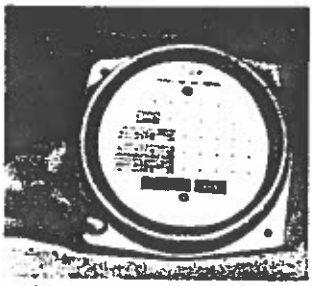
If existing wiring loom can be used,disconnect replacement loom from bushing and connect up existing heater and switch leads.

Connect motor and thermostat leads to correct terminals per removal sketch.

9 Syncroset actuators

Check that 'O' ring is in proper position in its groove. Apply a light coat of grease to ensure it remains in position. Replace terminal bushing. Before tapping back to shoulder in box check that no leads can be pinched between bushing and shoulder. Mount housing on gearcase and replace fixing screws. Replace terminal bushing retainer ring and the earth lug.

Reconnect external wiring. Check that Wiring Diagram on Code corresponds to actuator wiring and enter serial number on actuator nameplate on Cover Code Card. Ensure that 'O' ring is in position before replacing terminal box cover.



10 Syncroset actuators

Before fitting a replacement cover insure that:

1 'O' ring is in position on cover spigot.

2 Wiring diagram on code card corresponds to actuator wiring.

3 Serial number on actuator nameplate has been entered correctly on code card.

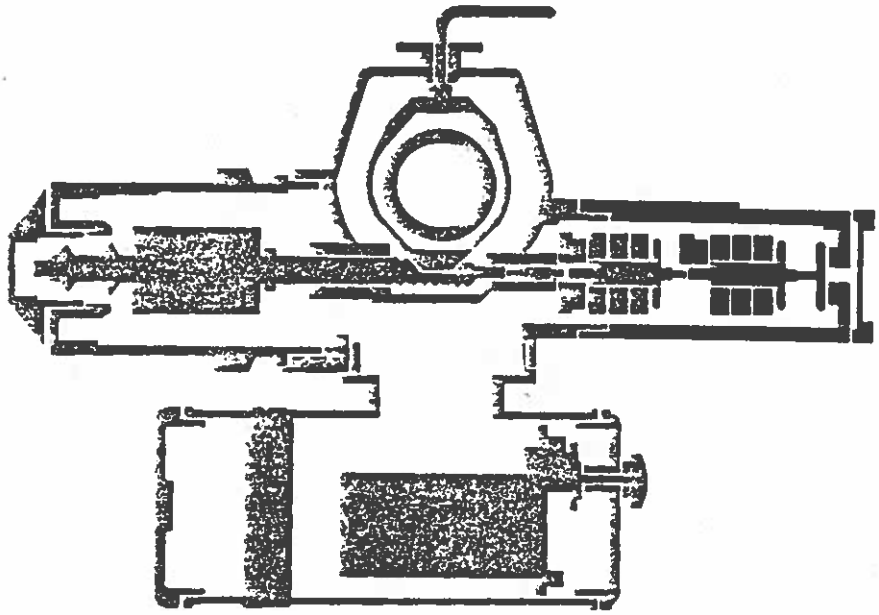
Tighten 4 remaining screws.

rotork actuation

Maintenance and spare parts manual for A range actuators

Sub-assembly 8 Add-on-Pak 1

Catalog section 5
Publication number AE5/4.8
Date of issue 9/90



Add-on-Pak 1 is a standard Rotork Sub-Assembly, which can be fitted in the field to either Syncropak or Syncroset actuators as an extension of the switch mechanism. It comprises:

One set of change gears.

Position indicator with adjusting mechanism. The pointer shows continuous proportional movement when Add-on-Pak 1 is fitted.

One Potentiometer.

Six changeover switches in two banks of three.

Extension housing and calibrated indicator dial.

Each bank is independently adjustable and can be set to operate at any point during valve travel. Each switch is single pole wired and the connection can at any time be reversed to make a normal closed contact normally open and vice versa.

Available parts

8a	Add-on-Pak 1 complete with switches and Potentiometer
8b	One set of switches
8c	One Potentiometer and Gear
8d	Current Position Transmitter (CPT)
8e	Add-on-Pak 1 cover

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Section 1	**Gear Ratio Selection** Selecting gears to suit number of output turns. Assembling gear clusters.
Section 2	**Fitting instructions** Checking whether switch mechanism has been pre-set. Removing switch mechanism cover and lamp assembly. Mounting AOP1 to switch mechanism.
Section 3	**Wiring up AOP1** To Syncropak 1400 series actuators. Syncroset 1400 series actuators. Earlier Syncropak actuators. Syncroset WP actuators.
Section 4	**Setting instructions** Setting intermediate auxiliary switches. Adjusting position indicator. Engaging Potentiometer gear drive. Fitting extension housing.

Section 1

Gear Ratio Selection

If you gave Rotork the number of output turns required when ordering, your AOP1 will be labelled Preset-fitted with the correct gear ratio.

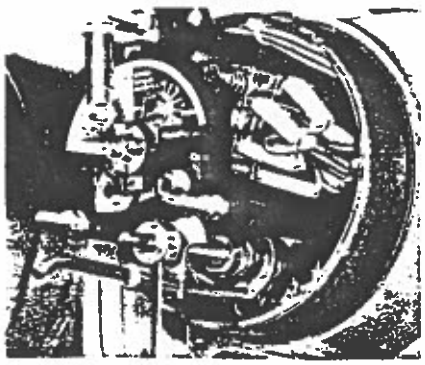
Check the label against your requirements: if it correlates you are ready to fit the AOP1 –See Section 2.

If it has not been preset you can select your gear ratio in the field as follows:

Selecting gears to suit number of output turns

Close the valve by motor or hand operation and remove switch mechanism cover by removing the three retaining screws using a 5/32" AF Allen Key. Pull cover off squarely using both hands.

Do not attempt to lever off with a screw driver as this will spoil 'O' Ring.



Observing nut A, operate the valve from one end of travel to the other and count the number of revolutions of the limit switch shaft (it will be between 1/3 and 32 turns).

Use the following table to determine the number of gear clusters and spacers you will require, depending on whether you have an earlier design AOP1 with plastic gears or current design with metal gears:-

Table A - Plastic gears

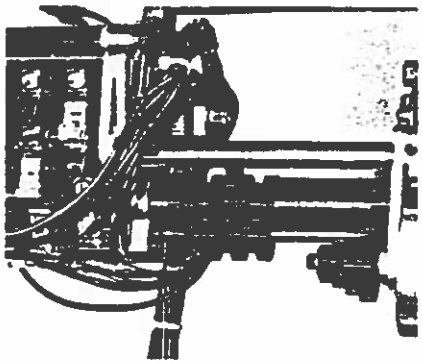
Turns of Limit Switch Shaft	Number of Clusters	Spacers
1/3 to 2/3	1	6
2/3 to 1 1/3	3	5
1 1/3 to 2 2/3	5	4
2 2/3 to 5 1/2	7	3
5 1/2 to 11	9	2
11 to 22	11	1
22 to 32	13	0

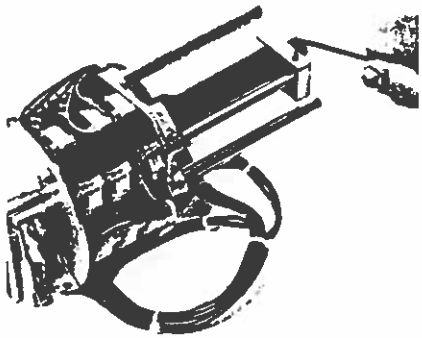
Table B - Metal gears

Turns of limit switch shaft	Number of gear clusters	Number of drive spaces
0.52- 1.04	1	8
1.05- 2.12	3	7
2.13- 4.28	5	6
4.29- 8.68	7	5
8.69- 17.53	9	4
17.54- 32.00	11	3

Assembling gear clusters

Take the main Add-on-Pak 1 assembly from the kit and check the number of changes on the input lay shafts. NB. The first larger pair is included in the number of clusters listed. The illustration shows as an example six gear clusters and three spacers, excluding drive adaptor.





Undo the steady using the 3/32" AF Allen Key provided, and adjust the number of gears and spacers to correspond with the number shown in the table.

Section 2

Fitting instructions

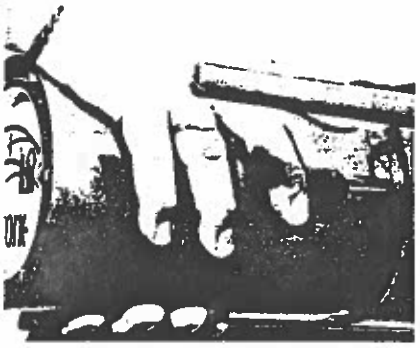
Your switch mechanism should have already been set to suit valve. Checking whether switch mechanism has been preset.

Operate valve to fully open and shut positions.

The Indicator pointer should move quickly from the centre to OPEN position just before valve back seats, and to SHUT just before it seats - see separate Rotork publication AE5/0.

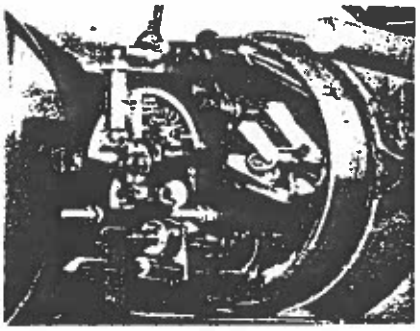
Removing switch mechanism cover and lamp assembly

Isolate electrical supplies. Remove the three retaining screws using a 5/32" AF Allen Key.



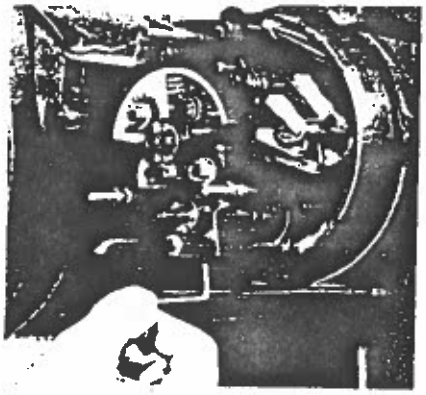
Pull cover off squarely using both hands.

Do not attempt to lever off with a screwdriver as this will spoil 'O' Ring.



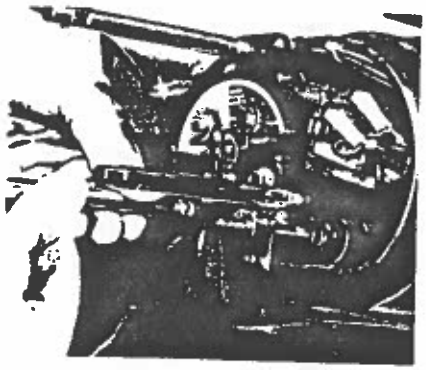
Loosen nut and washer, free the Syncropak lamp assembly and allow it to hang down on its wire.

Retighten the washer and nut.

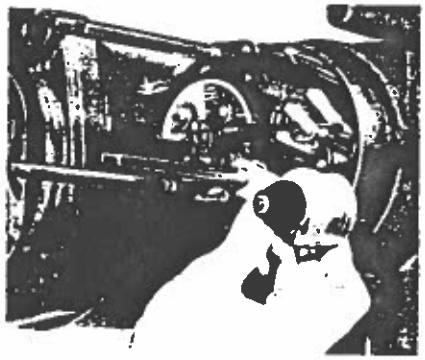


Remove the indicator drive from the front of the limit switch shaft using the 1/16" AF Allen Key.
Discard this component.

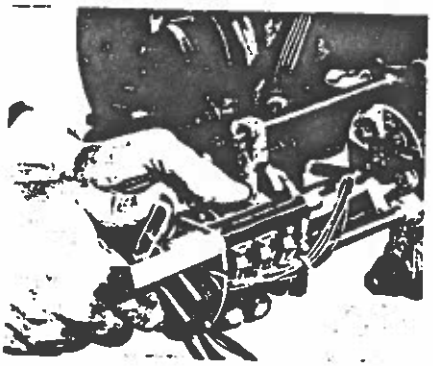
Mounting AOP1 to switch mechanism



From your AOP1 kit fit the three mounting pillars.



If the Potentiometer is to be fitted slide it on its bracket on to mounting pillar as shown. (lower right).
The gear cluster should be facing away from the switch mechanism. Slide it as near the switch mechanism as it will go.

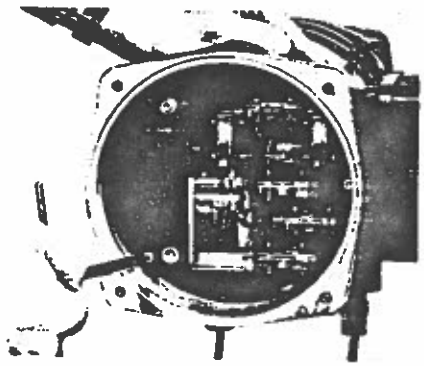


With the valve in a mid position, offer the AOP1 to the switch mechanism with the wiring harness in the position shown.
Engage the input shaft drive slot with the switch mechanism drive pin.
If they do not align, continue to turn the AOP1 input shaft or the indicator mechanism until they engage.
Push assembly fully home on the mounting pillars and tighten the three set screws using a 3/32" AF Allen Key to retain the main assembly to the pillars.

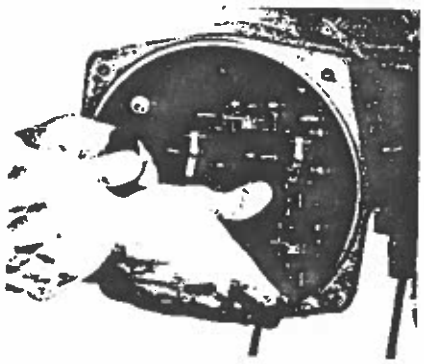
Turn the indicating mechanism fully clockwise against the clutch. Close the valve fully. The final position of the mechanism should be 1/16" (1.5mm) from the close stop.

Wiring up AOP1 to Syncropak Actuators
Remove starter cover by unscrewing the four retaining screws, using two of them in the threaded jacking holes.

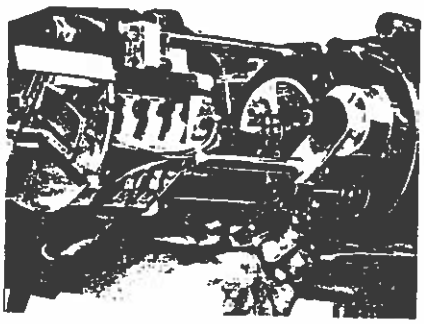
Do not attempt to lever off cover with screwdriver as this will spoil 'O' ring seal.



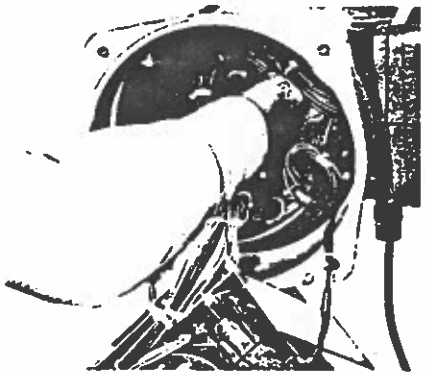
Remove the three switch plate retaining screws.



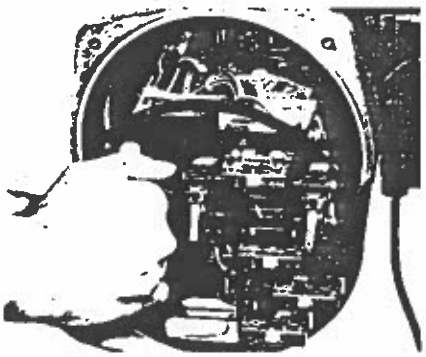
Withdraw starter and allow to hang naturally from restraint strap.



Feed the Add-on-Pak 1 wiring harness through the gearcase beneath the switch mechanism wiring harness, and into the starter housing.



Using your wiring diagram, connect up to the terminals at the back of the terminal bush.

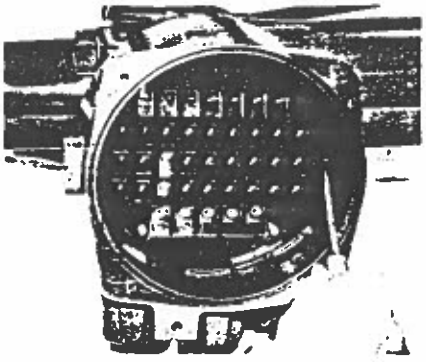


Insert chassis making sure that slide rails engage with channels, and ensuring that no cables are trapped between starter chassis and casting. Push home and replace the three retaining screws.

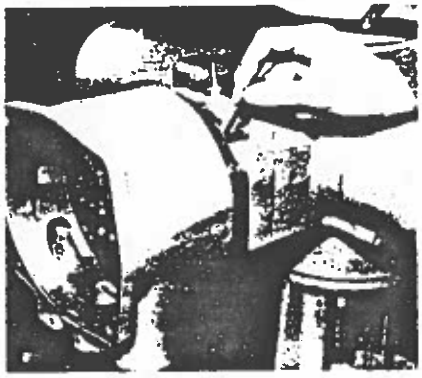
Check that 'O' Ring on cover spigot is in perfect condition before replacing starter cover. If it is damaged replace with new ring - a spare should be found in the terminal box.

Wiring up AOP1 to Syncroset 2 Actuators

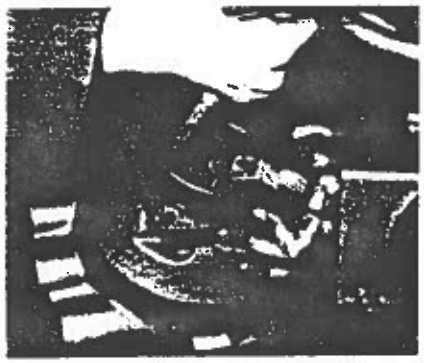
Remove terminal box cover, disconnect and withdraw external wiring.



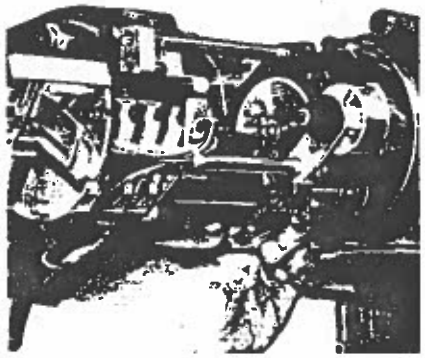
Remove the terminal inside terminal box and lever out the spring retainer.



Remove the four 3/16" AF screws securing the Syncroset housing to the gear case.



Withdraw terminal bushing from housing by carefully tapping around edge of bushing inside housing with a wooden handle.



Feed the Add-on-Pak 1 wiring harness through the gearcase beneath the switch mechanism wiring harness and through the terminal box.

Using the wiring diagram, connect the wires to the back of the terminal bush. Replace the terminal bush in its housing, wind in the spring retainer and replace the terminal. Refit Syncroset housing to gearcase.
Reconnect external wiring. Check that 'O' Ring is in good condition and replace the terminal box cover.

To earlier Syncropak Actuators and Syncroset SP Actuators

Fit additional terminal block provided in appropriate place.
Cut off push-on connectors from terminal end of wiring harness, and cut back insulation 1/4".
Push wiring harness through into terminal box and connect in accordance with wiring diagram.

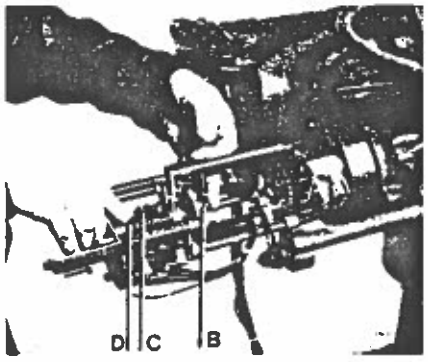
Section 4

Setting instructions

Setting intermediate auxilliary switches

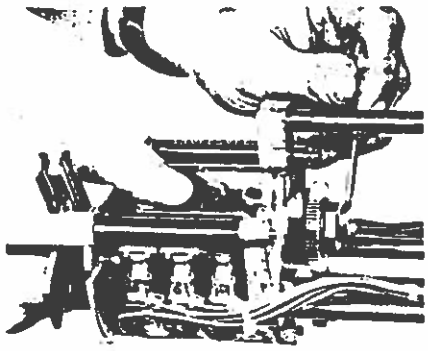
Note: Instructions are for clockwise closing - for anti-clockwise read opening for closing etc.

From the closed position operate valve to the point at which switches are required to trip in CLOSING direction.



Loosen nut B at rear of cam shaft, set inner cam C so that it just trips switches IAS4,5 and 6. Partially tighten nut B.

Operate valve to the point at which switches are required to trip OPENING direction.

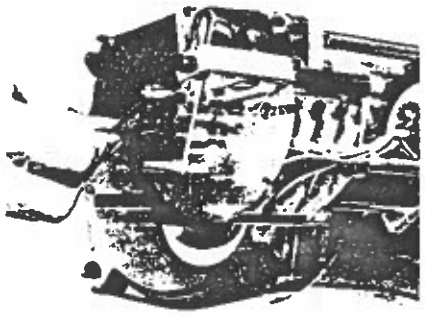


Loosen nut B again, set outer cam D to trip switches IAS1,2 and 3. Tighten nut B to approximately 10lb ins (.6Nm).

DO NOT OVER TIGHTEN

Adjusting position indicator

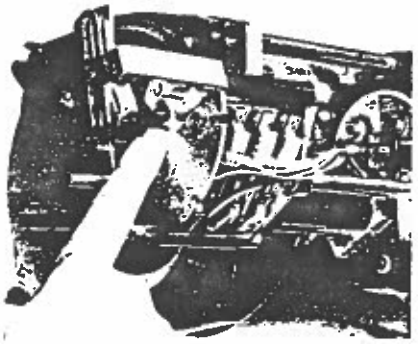
If your AOP1 was not preset by Rotork the indicator will require adjusting.



Loosen indicator scale adjusting screw using 3/32" AF Allen Key. Adjust the position of the screw in its slot so that, with the valve fully open, there is a clearance of up to 1/16" (1.5mm) between the foot of the widest slotted plate and the stop. Tighten screw fully.

Engaging Potentiometer gear drive

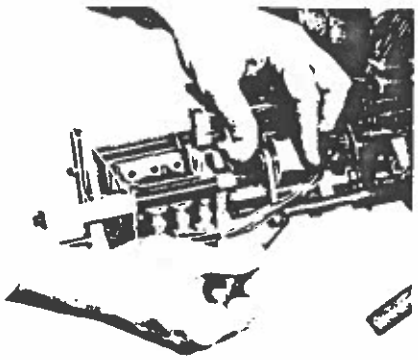
(Valve still fully open).



On the front plate there is a scale numbered 1 - 4. When the valve is fully open, note the number at which the pin is pointing.

Refer to the table below to ascertain which Potentiometer gear to mesh with the main Potentiometer drive gear.

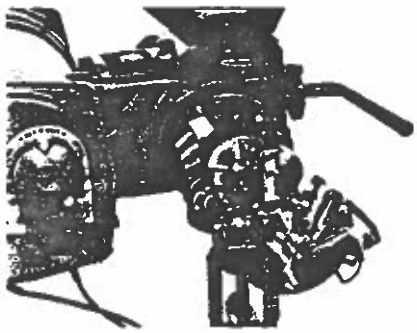
Sector number	Gear to mesh with Main Gear
1	1 (Smallest)
2	2
3	3
4	4 (Largest)



Slide the Potentiometer along the mounting pillar and before engaging rotate the Potentiometer spindle so that it is approximately in mid-travel.

Mesh with the correct gear and clamp using 3/32" AF Allen Key.
The Potentiometer will now set itself to zero when the valve is shut.

Fitting extension housing



Refit the lamp assembly on Syncropak.

There is enough wire in the wiring harness to pull it out to its new position.

Slide extension housing in place of original switch mechanism cover, and secure, checking that sound 'O' ring is in place.

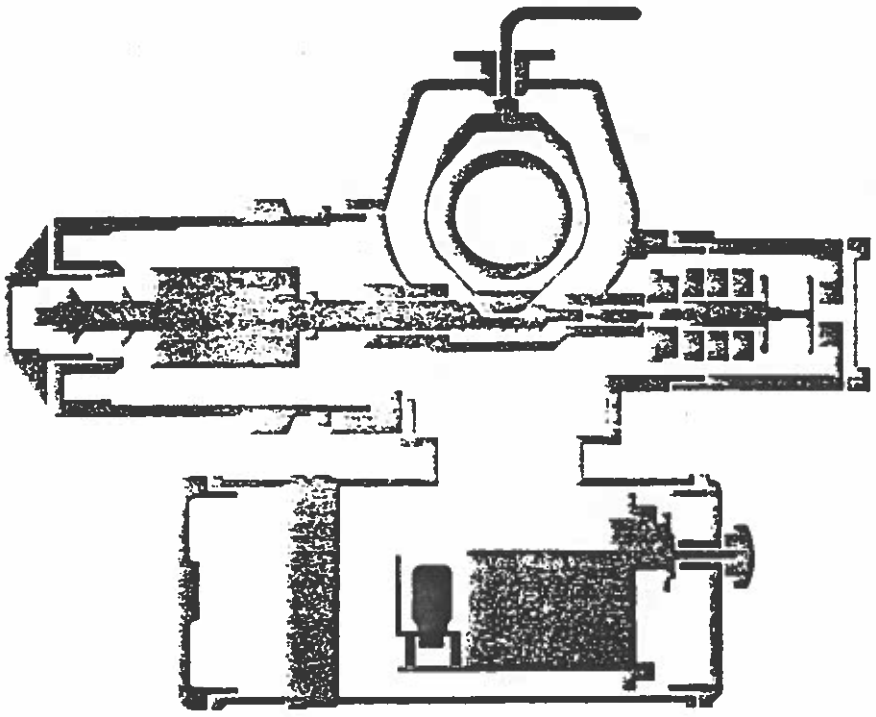
rotork actuation

Maintenance and spare parts manual

Sub-assembly 9

Optional electrical extras for 'A' Range Actuators types 1200 and 1400 series

Catalog section 5
Publication number AE5/4.9
Date of issue 3/90



Syncropak actuators are available with standard optional extras designated below. It is important when ordering to specify the value and figure number of the relay or other component being replaced.

Non-standard optional extras incorporated in Syncropak actuators are housed in a special deep cover fitted to the terminal compartment. Spare parts for proprietary supervisory controls and other spare parts fitted in this cover should be ordered directly from the manufacturer.

Available parts

9a	Plug-in relays, 50v DC.
9b	Plug-in relays of other voltages to be specified.
9c	Timer sub-assembly.
9d	Phase discriminator.
9e	Monitor relay assembly (specify voltage)
9f	2 x relay assembly (specify voltage)
9g	3 x relay assembly (specify voltage)

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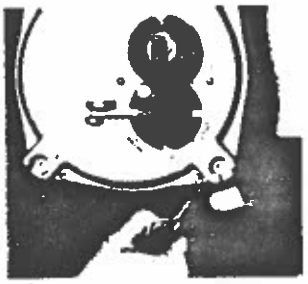
Dismantling

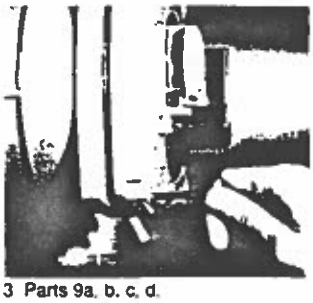
Isolate incoming electrical supply to actuator.

1 Parts 9a, b, c, d.



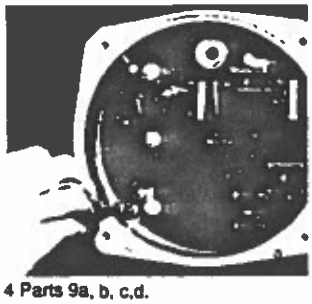
2 Parts 9a, b, c, d.

Break Quality Control seal on starter cover.



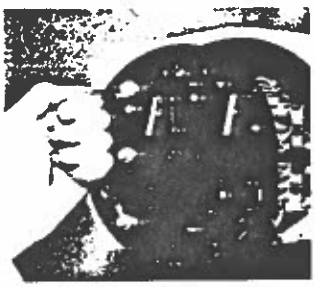
3 Parts 9a, b, c, d.

Unscrew the 4 capscrews and remove cover. If necessary use two capscrews in threaded jacking holes in cover. Do not use a screw-driver which can damage 'O' ring seal.



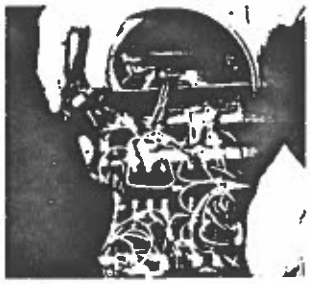
4 Parts 9a, b, c,d.

Remove rubber clamping strip (if fitted) and unscrew 3 frontplate retaining screws.



5 Parts 9a, b, c, d.

Withdraw starter chassis and let it hang naturally from its restraint strap.

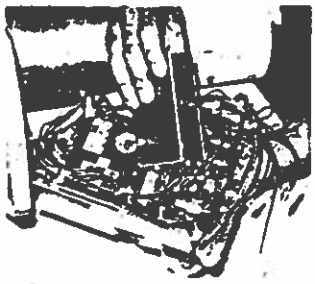


6 Parts 9a, b, c.

Plug-in relays and the timer are mounted at the far end of the starter chassis.

Remove defective relay or timer.

Plug in replacement and press spring clip into position over casing.



7 Part 9d.

The phase discriminator is located immediately behind the front-plate, adjacent to the transformer.

To replace remove the two screws securing assembly to the chassis. Remove wire No 51 from fuse on underside of chassis. Remove remaining wires one at a time and refit corresponding wire on new unit.

Discard faulty unit, feed wire No 51 through to underside of chassis and replace the two securing screws.

Fit wire No 51 to fuse on underside of chassis.

8 Parts 9a, b, c, d.

Replacement

Re-insert starter chassis making sure that the slide rails engage with channels in housing.

Push firmly in place after first checking the wiring harness is out of the way and no wires will be pinched. Replace the 3 retaining screws and rubber clamping strip, (if fitted). Replace starter cover and 4 retaining screws.

Crimp on Quality Control seal provided.

After reconnection of external wiring, refer to Section 6 of Instruction Manual AE5/0 for Electrical Startup.

Before replacing terminal box cover check that wiring diagram on code card corresponds to actuator wiring and enter serial number on actuator nameplate on cover code card.

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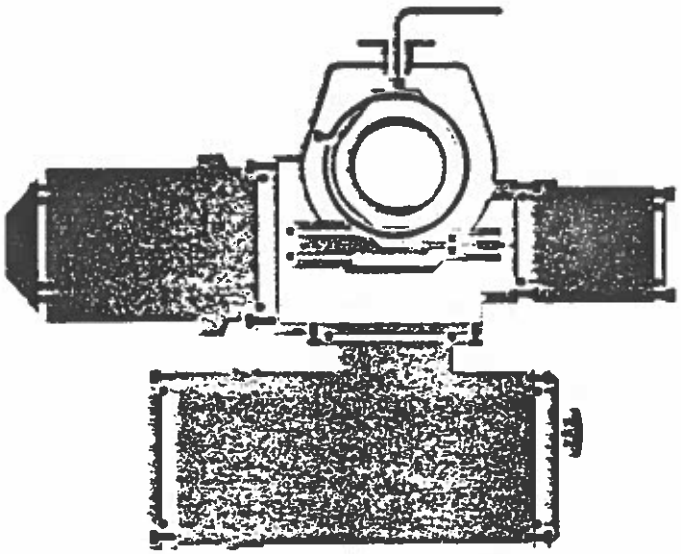
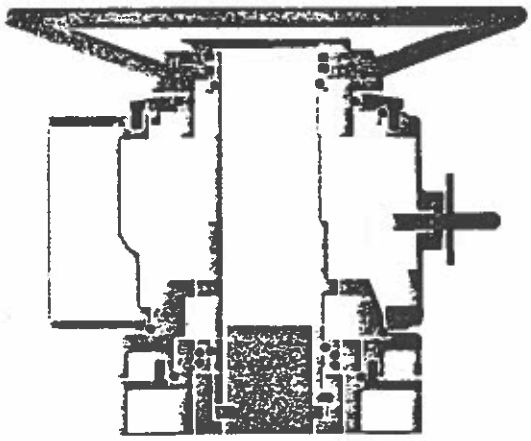
rotork actuation

Maintenance and spare parts manual

Sub-assembly 11
Oil seals, 'O' rings and Screws kit
'A' Range actuators

Catalog section 5
Publication number AE5/4.11
Date of issue 11/90





Oil seals, 'O' rings and screw kits comprise sets of 'O' rings, seals and screws that may be needed as replacements for parts mislaid during startup and damaged or lost during dismantling.

The kits include detailed drawings and information showing the position of the parts in the actuator assembly.

Each kit includes a long handled Allen wrench for handy opening of switch compartments and terminal compartment covers, and Allen wrenches for all other screws.

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Available parts

11a Oil seals, 'O' rings and screws kit for 7A, 11A and 13A

11b Oil seals, 'O' rings and screws kit for 14A - 30A and 14AR - 30AR

11c Oil seals, 'O' rings and screws kit for 40A - 90A and 40AR - 90AR

11d Oil seals, 'O' rings and screws kit for 91AR and 95A

Oil seals, 'O' rings and screws kit incude:

Parts

Switch, cover screws and 'O' ring.

Dial indicator fixing screws and 'O' ring.

Motor cover and end cover screws and 'O' rings.

Cover screws and 'O' rings for Syncropak and Syncroset covers.

Top and side handwheel retaining rod assembly.

Centre column top and base oil seals and 'O' rings.

Clutch lever fixing pin and oil seal.

Wormshaft oil seals.

Torque plunger adjustment screw and seals.

Side handwheel oil seals.

Drive bushing retainer locking screw.

Fuses and indicating lamp for Syncropak actuator.

Tools

Long handled Allen wrench for cover screws.

Allen wrenches for all other capscrews.

Long handled nut driver for electrical terminal nuts.

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Maintenance and spare parts manual

Spare parts stock guide for A Range Actuators

Catalog section 5
Publication number AE5/4.21
Date of issue 12/90

Recommended spare part stock quantities

Sub-assembly		Actuator Holding 1-10	11-49	50-99	100+	Nature of sub-assembly holding (ref only)
1a	Actuator gearcase	-	-	1	2	maintenance spare
1d	Gearcase oilseals and maintenance kit	1	4	6	10	construction spare
2a	Type A drive bushing	-	1	3	5	maintenance spare
2b	Type A drive bushing retainer	-	1	1	2	maintenance spare
2c	Type AZ drive bushing	-	1	3	5	maintenance spare
2d	Type AZ drive bushing retainer	-	1	1	2	maintenance spare
2e	Type AR drive bushing	-	-	-	-	maintenance spare
3a	Switch mechanism	1	2	5	8	maintenance spare
3b	Switch bank (2 sets of 3)	1	2	5	8	maintenance spare
3c	Switch mechanism + cover	-	2	5	8	construction spare
3d/1	Indicator dial, pre 1978	1	4	6	8	construction spare
3d/2	Indicator dial, current design	1	4	6	8	construction spare
4a	Top handwheel	-	1	1	2	construction spare
4b	Side handwheel	-	-	1	2	construction spare
5a	Motor & worm gear	1	2	5	8	maintenance spare
5b	Oilseals (motor)	1	2	5	8	maintenance spare
6a	Syncropak starter & housing complete	1	2	5	8	maintenance spare
6b	Starter & chassis	1	2	5	8	maintenance spare
6c	Contactor assembly	1	2	5	8	maintenance spare
6d	Transformer	1	1	3	5	maintenance spare
6f	Syncropak cover with pushbutton station	1	2	5	8	maintenance spare
7a	Syncroset EP/WT terminal housing	-	1	1	2	construction spare
7b	Syncroset FLP terminal housing	-	1	1	2	construction spare
7c	Syncroset EP/WP/FLP terminal housing cover	-	1	1	2	construction spare
7d	Syncroset WP terminal housing	-	1	1	2	construction spare
7e	Syncroset WP terminal housing cover	-	1	1	2	construction spare

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Sub-assembly		Actuator Holding				Nature of sub-assembly holding
		1-10	11-49	50-99	100+	(ref only)
8a	Add-on-Pak 1 complete	-	2	5	8	optional extra
8b	Switch banks (2 sets of 3)		2	5	8	optional extra
8c	Potentiomenter & gear	1	2	5	8	optional extra
9a	Plug in relay 50V D.C.	-	1	3	5	optional extra
9b	Plug in relay voltage to be specified	-	1	3	5	optional extra
9c	Timer	-	1	3	5	optional extra
9d	Phase discriminator	-	1	3	5	optional extra
11a/1	Allen keys (4) extension allen key (3) screwdrivers (2)	1	2	5	10	7A/11A/13A maintenance spare
11a/2	Screws, circlips, nuts and bolts	1	2	5	10	7A/11A/13A maintenance spare
11a/3	Seals and 'O' rings	1	2	5	10	7A/11A/13A maintenance spare
11a/4	Connections, fuses and lamp	1	2	5	10	7A/11A/13A maintenance spare
11b/1	Allen keys (4) extension allen keys (3) screwdrivers (2)	-	1	2	5	14A/30A maintenance spare
11b/2	Screws, circlips, nuts and bolts	-	1	2	5	14A/30A maintenance spare
11b/3	Seals and 'O' rings	-	1	2	5	14A/30A maintenance spare
11b/4	Connections, fuses and lamp	-	1	2	5	14A/30A maintenance spare
11c/1	Allen keys (4) extension allen keys (3) screwdrivers (2)	1	2	5	10	40A/95A maintenance spare
11c/2	Screws, circlips, nuts and bolts	1	2	5	10	40A/95A maintenance spare
11c/3	Seals and 'O' rings	1	2	5	10	40A/95A maintenance spare
11c/4	Connections, fuses and lamp	1	2	5	10	40A/95A maintenance spare
11a	11a/1 + 11a/2 + 11a/3 + 11a/4	1	2	5	10	7A/11A/13A maintenance spare
11b	11b/1 + 11b/2 + 11b/3 + 11b/4	-	1	2	5	14A/30A maintenance spare
11c	11c/1 + 11c/2 + 11c/3 + 11c/4	1	2	5	10	40A/95A maintenance spare

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Maintenance and spare parts manual

Spares module weights (kg) for A range Actuators

Catalog section 5
Publication number AE5/4.22
Date of issue 4/91

Module number	Module description	Actuator size 7A	11/13A	14A	16A	30A	40A	70A	90/95A
1a	Gearcase. Base. Center column	18	18	30	30	38	64	65	68
1d	Maintenance kit	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
2a	Type 'A' drive bush	0.25	0.25	1	1	2.5	3	4.25	4.25
2b	Type 'A' drive bush retainer	0.25	0.25	0.5	0.5	1.25	1.5	2.75	2.75
2c	Type 'AZ' drive bush	0.5	0.5	1.75	1.75	3	3	6	6
2d	Type 'AZ' drive bush retainer	0.5	0.5	1.25	1.25	2.75	2.75	6.5	6.5
2e	Type 'AR' drive bush	–	–	–	–	–	3.25	5	5
3a	Switch mechanism assembly	0.75							
3a/1	Switch mechanism adaption kit	0.25	Components weights for						
3b	Switch banks	0.25	Modules 3a – 3D/2						
3c	Switch mechanism and cover assembly	2	are all the same for all						
3d/1	Indicator dial kit (prior April 1978)	0.25	actuator sizes.						
3d/2	Indicator dial switch (April 1978 forward)	0.25							
4a	Top wheel assembly	1.25	1.25	9	10	14	16	–	–
4b	Side handwheel assembly	–	–	–	–	18	20	30	30
5a	Motor and wormgear assembly	4.5	5.5	6.5	6.5	13	22	32	34
5b	Oilseal kit for Module 5a	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
6a	Syncropak starter and casing	8.5	8.5	8.5	8.5	8.5	10	10	10
6b	Starter chassis assembly	3.75							
6c	Contactor assembly	1							
6d	Transformer assembly	1.25							
6f	S/Pak pushbutton/cover assembly	1.5							
6g	Lamp and fuse kit	0.25							
7a	Syncroset EP/WT terminal housing	3.75							
7b	Syncroset F/P terminal housing	12							
7c	S/Set EP/WT/FP terminal housing cover	0.5	Component weights for						
7d	S/Set W/P terminal housing	3.5	Modules 6b – 9d						
7e	S/Set W/P terminal housing cover	0.5	are the same for all						
8a	Add-on-Pak 1 assembly and cover	3.75	actuator sizes.						
8b	Switch banks	0.25							
8c	Potentiometer and gear assembly	0.25							
9a	Plug in relay 50V DC	0.25							
9b	Plug in relay (Voltage to be specified)	0.25							
9c	Timer	1.5							

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Module number	Module description	Actuator size 7A	11/13A	14A	16A	30A	40A	70A	90/95A
9d	Phase discriminator	0.75							
11a	Comprehensive kit 'O' rings, seals, tools	1.5	1.5						
11b	As above			2.5	2.5	2.5			
11c	As above						3.25	3.25	3.25
11a/1	Tool kit	3	3						
11b/1	Tool kit			3	3	3			
11c/1	Tool kit						3	3	3
11a/2	Screw and circlip kit	0.5	0.5						
11b/2	As above			0.5	0.5	0.5			
11c/2	As above						0.5	0.5	0.5
11a/3	Seal and 'O' ring kit	1.5	1.5						
11b/3	As above			1.5	1.5	1.5			
11c/3	As above						1.5	1.5	1.5
11a/4	Electrical component kit	0.5	0.5						
11b/4	As above			0.5	0.5	0.5			
11c/4	As above						0.5	0.5	0.5

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Spare parts list for 'A' Range actuators

7/11/13A actuators Mechanical assemblies

Catalog section 5
Publication number AE5/5.1
Date of issue 5/90

Item no.	Qty.	Component description
7/11/13A Gearcase		
1	1	Gearcase
2	1	Limit switch worm
3	1	Centre column
4	1	Oilseal Gaco 52728 52 x 72 x 8
5	1	Bearing SKF 6209-2RS 45 x 85 x 19
6	1	Bearing stop ring
7	1	Retaining pin
8	3	Taper plug 3/8" BSP (was 1/2" to 12/82)
9	1	Hand/autolever
10	1	'O' ring 200-111-4460
11	1	Lever spring return
12	1	Hand/auto jack
13	1	Hand/auto lever stop
14	1	Spring finger
15	1	5/16" Spring washer
18	1	Needle bearing Ina HK1012 10 x 14 x 12
19	1	Needle bearing Ina HK1816 18 x 24 x 16
20	1	Wormshaft
21	2	Oilseal Ina G 18 x 24 x 3
22	1	Oilseal Gaco SM14247 14 x 24 x 7
23	1	Torque plunger
26	1	Limit switch wheel
27	1	Spirol pin 1/8" x 5/8"
28	1	Clutch ring
29	2	Clutch key
30	1	Clutch spring
31	1	Washer
32	1	Circlip Anderton DIN 1400-40M
33	1	Plastic bung
37	1	Type A drive bush retainer
38	1	Skt set screw 5/16" UNF x 1/4"
39	1	Type A drive bush
41	1	Type AZ drive bush retainer
42	1	Type AZ drive bush
48	1	Handwheel retainer
51	1	Extractor plug body
56	1	Wormwheel
79	1	Finger stud
80	1	Sealing washer
83	1	Washer
90	1	Countersunk steel screw 6-23 UNC x 3/8" LG
7/11/13A Handwheel		
43	1	Handwheel
44	1	Oilseal Halls NA579
45	1	'O' ring Dowty 200-335-4460
46	1	Bung
47	2	Skt hd capscrew 10-24 UNC x 1/2" LG
53	1	Screwed cover tube assembly
96	1	Enlarged 18" (455mm) handwheel (13A only)
7/11/13A Motor		
54	1	Wormshaft only supplied with Wormwheel (56)
55	1	Steel ball 1/4" dia.
57	1	Stator rotor unit
58	1	Motor cover
61	1	Bearing Skf 6201-2RS 12 x 32 x 10
62	1	Spacer
63	2	Hex lock nut
64	1	'O' ring Dowty 200-124-4460/75
65	1	Motor end cap
66	3	Capscrew skt hd 10-24 UNC x 5/8"
67	6	Steel washer 10-24 UNC x 1" dia.
68	3	Capscrew skt hd 10-24 UNC x 3/4"
69	1	'O' ring Dowty 200-536-4460/75
75, 76, 78, 82, 85		Disc springs and spacers (Combinations vary according to output torque)

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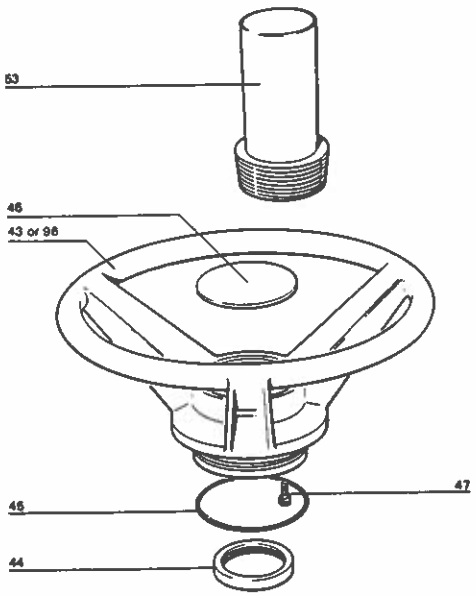
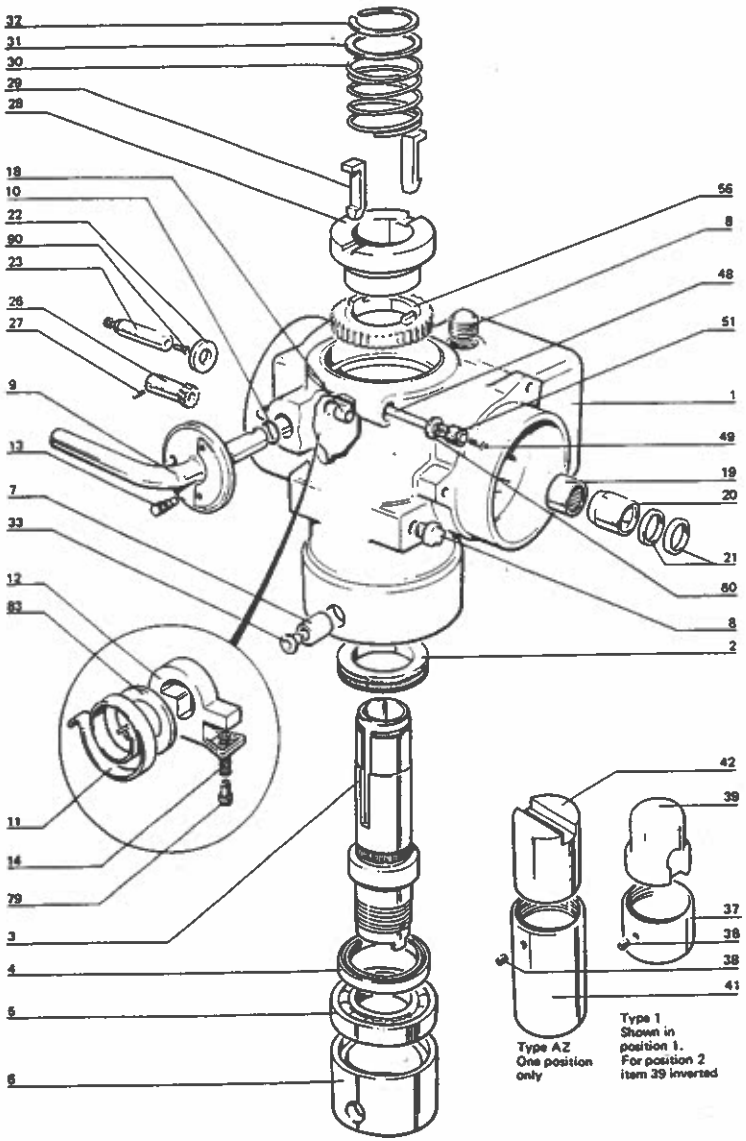
USA, New York City	(201) 646 9596	(201) 646 9288
USA, Philadelphia	(215) 696 7302	(215) 696 7354
Venezuela, Caracas	(2) 323536	(14) 250822

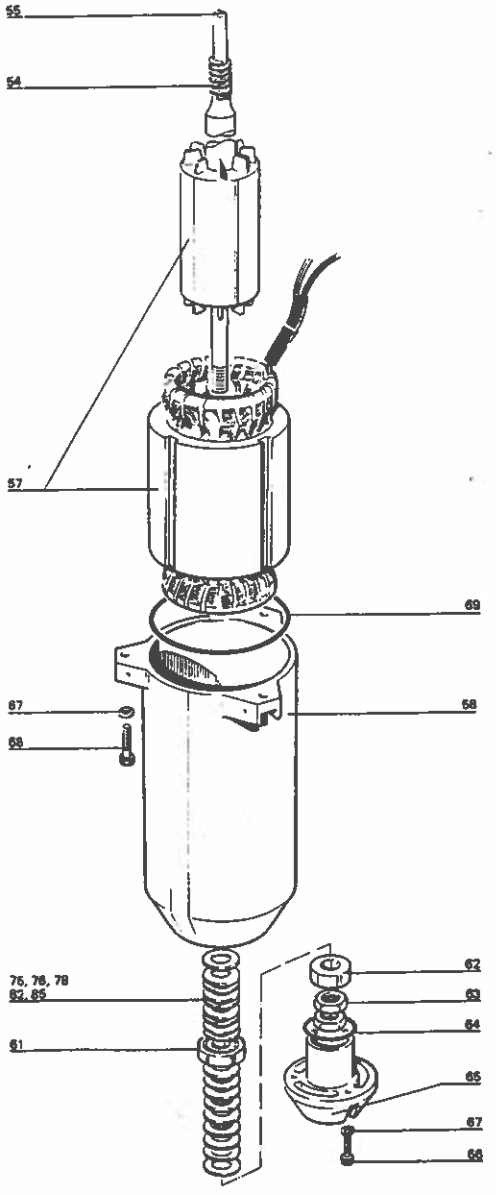
Handwheel assembly



Gearcase/drive sleeve/thrust base



Motor



rotork actuation

Spare parts list for 'A' Range actuators

14/16A actuators Mechanical assemblies

Catalog section 5
Publication number AE5/5.2
Date of issue 3/93

Item no.	Qty.	Component description
14/16A Gearcase		
1	1	Gearcase
2	1	Thrust base
3	1	Gearbox base
8	1	Centre column
9	1	Bearing stop ring
10	1	Yoke
11	1	Hand auto lever
12	1	Hand/auto finger
14	1	Finger return spring
15	1	Thrust pad
16	1	Locating pin
17	1	Hand auto cam
19	1	Limit switch worm
21	1	Wormwheel
22	1	Drive bush (Type A or AZ)
23	1	Drive bush retainer (Type A or AZ)
25	1	Clutch spring
26	1	Clutch ring
27	2	Clutch key
28	2	Drive pin
29	1	Wormshaft F/P shroud
30	1	Finger spindle
31	1	Clutch spring washer
32	1	Roller (Hand/Auto)
34	2	Spirol pin 5/16" x 1" LG
41	1	Bearing (Centre column/Thrust base SKF 51114 70 x 95 x 18
42	1	Wormshaft bearing
43	1	Bearing (Wormshaft) INA HK 3026 30 x 37 x 26
46	1	'O' Ring 200-249-4460
47	1	'O' Ring 200-036-4460
51	2	'O' Ring 200-339-4460
52	1	'O' Ring 200-331-4490
53	1	'O' Ring 200-006-4460
55	2	Oilseal (Wormshaft) 30 x 40 x 7
56	1	Oilseal (Hand auto lever) 15 x 30 x 10
57	2	Oilseal (Torque plunger) 8 x 16 x 7
59	1	Redcap
62	1	Sel-lok pin 25mm x 5mm
63	1	Split pin
64	1	Sel-lok pin 1/2" x 1/16" dia
65	1	Steel Unbrako SKT HD Setscrew knurled
66	1	Skt setscrew 1/4" UNC x 13/4"
67	2	Skt setscrew 10-24 UNC x 5/16" LG
68	2	Sel-lok 3/8" x 1/16" dia.
69	8	Skt Capscrew 3/8" UNC x 1" LG
70	4	Skt Capscrew 1/4" UNC x 3/4" LG
71	4	Skt Capscrew 1/4" x 1" LG
79	1	Hex full nut 1/4" UNC
84	1	F/P Shroud (Torque plunger)
86	3	Taper plug 1/2" BSP
89	1	Cam return spring
97	1	Limit switch wheel
98	1	Limit switch shaft
99	2	Spirol pin 5/8" x 1/8" dia.
103	1	Spacer
104	1	Torque plunger
147	1	Handwheel retainer
152	1	Extractor body
154	1	Sealing washer
177	1	Spacer

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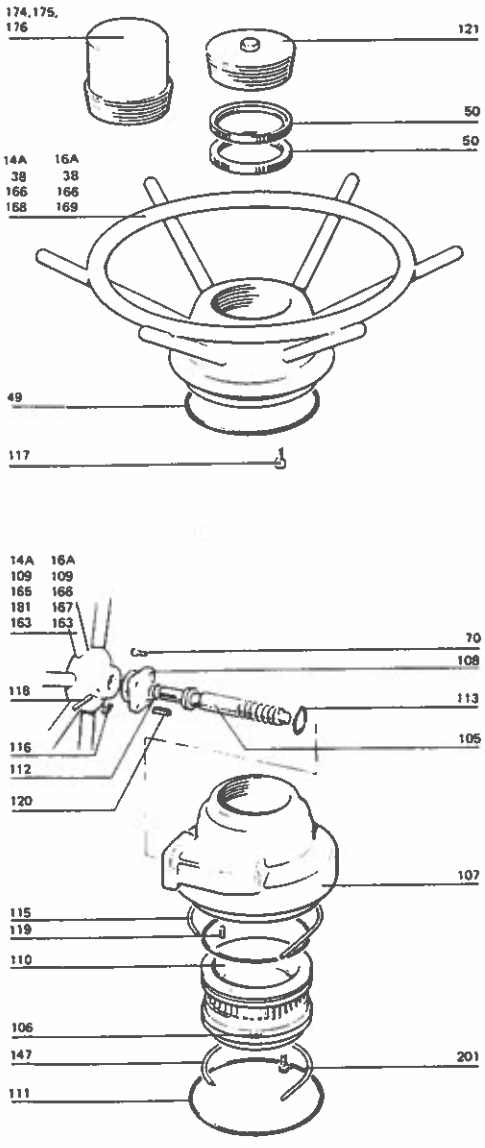
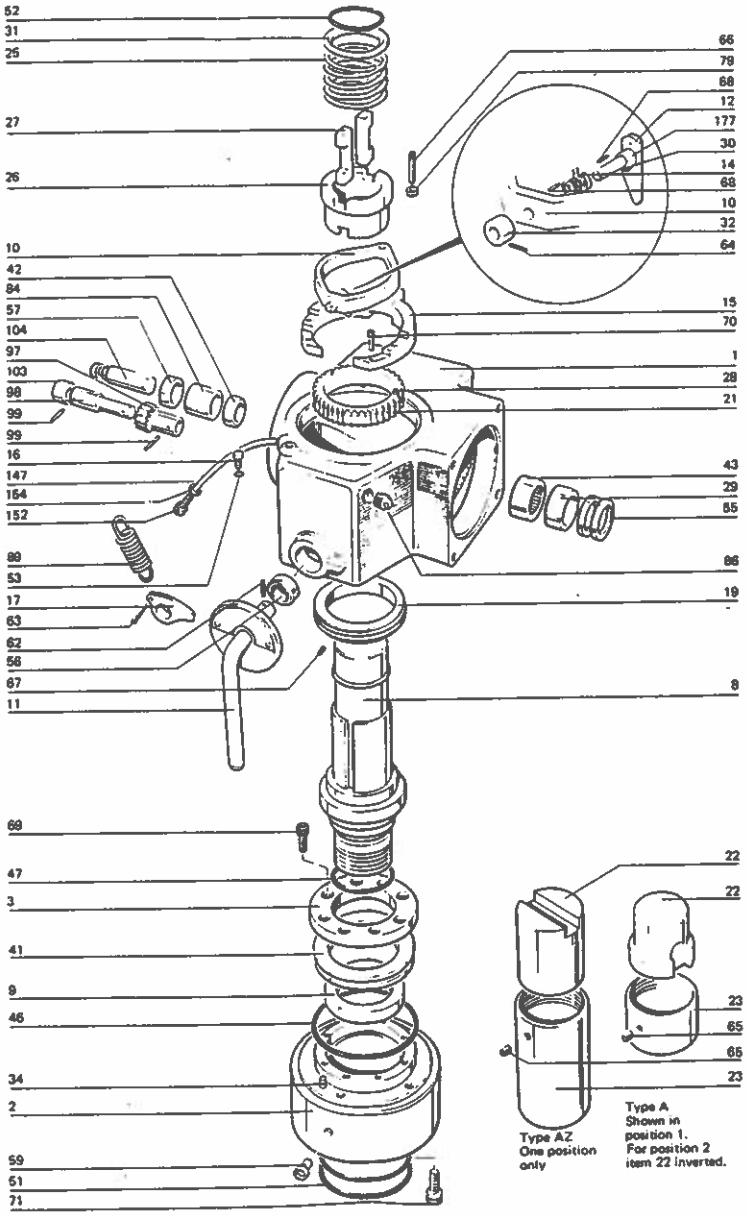
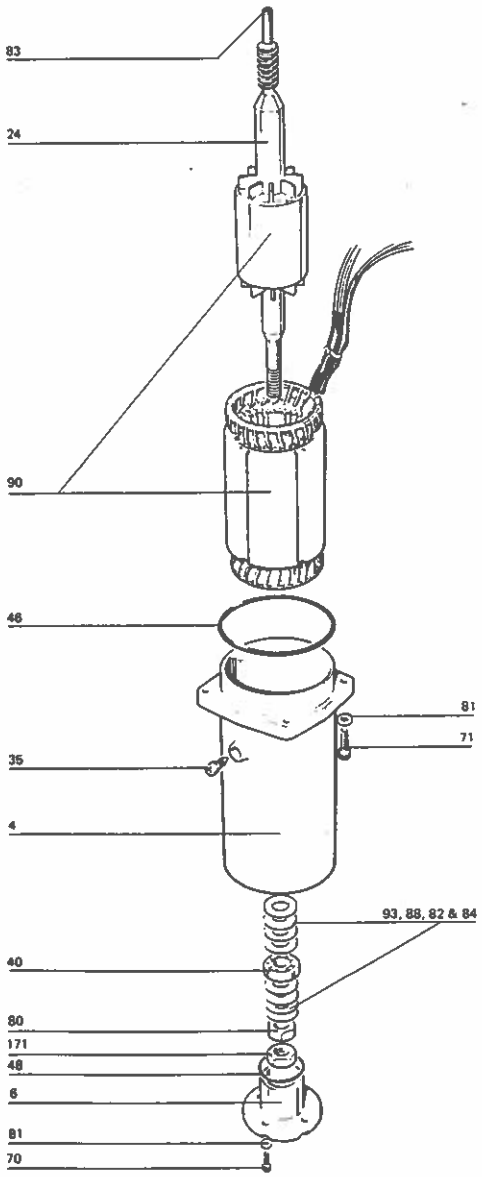
Handwheel assembly



Gearcase/drive sleeve/thrust base



Motor



Item no.	Qty.	Component description
14/16A Handwheel		
38,166 168	1	14A Top handwheel
38,166 169	1	16A Top handwheel
49	1	'O' Ring 200-352-5560
50	2	Oilseal W31523639-R4 Weston
117	2	Capscrew 5/16" UNC x 3/4" LG
121	1	Screwed bung
174, 175, 176	1	Screwed cover tube
14/16A Side handwheel		
70	4	Skt capscrew 1/4" UNC x 3/4" LG
105	1	Wormshaft
106	1	Wormwheel
107	1	Worm casing
108	1	End housing
109, 165 181, 163	1	14A Side handwheel and handle
110	1	'O' Ring 200-344-4460
	1	'O' Ring Gaco R4500
2	1	'O' Ring 200-114-4460
113	1	'O' Ring 200-214-4460
115	1	Wormwheel retainer
116	1	Grease nipple
118	2	Setscrew 10-24 UNC x 1/2" LG
119	2	Spirol pin 1/4" dia. x 1 1/8" LG
120	1	Key 3/16" Sq x 1 1/8" LG
147	1	Handwheel retainer
201	2	Drive pin
14/16A Motor		
4	1	Motor cover
6	1	Motor end cap
24	1	Wormshaft 20:1, 30:1, 40:1, 60:1, 80:1 only supplied with Wormwheel (21)
35	1	Stator locking screw
40	1	Bearing (motor end cap)
46	1	'O' Ring 200-249-4460
48	1	'O' Ring 200-226-4460
70	4	Skt capscrew 1/4" UNC x 3/4" LG
71	4	Skt capscrew 1/4" UNC x 1 LG
80	1	Hex lock nut
81	8	Washer std 1/4" I/D
83	1	1/4" dia steel ball
90	1	Stator rotor unit
83, 88, 84		Disc spring and spacer (Combinations vary according to output torque)
1	1	Hex lock nut

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Spare parts list for 'A' Range actuators

30A actuator Mechanical assemblies

Catalog section 5
Publication number AE5/5.3
Date of issue 7/90

Item no.	Qty.	Component description
30A Gearcase		
1	1	Gearcase
2	1	Thrust base
3	1	Thrust ring
8	1	Centre column
9	1	Bearing stop ring
10	1	Yoke
11	1	Hand auto lever
12	1	Hand auto finger
14	1	Finger return spring
15	1	Thrust pad
16	1	Locating pin
17	1	Hand auto cam
19	1	Limit switch worm
21	1	Wormwheel
22	1	Drive bush (Type A or AZ)
23	1	Drive bush retainer (Type A or AZ)
25	1	Clutch spring
26	1	Clutch ring
27	2	Clutch key
28	2	Drive pin
29	1	Worm shaft FLP shroud
30	1	Finger spindle
31	1	Clutch spring washer
32	1	Hand auto roller
34	2	Spirol pin 5/16" x 1" LG
41	1	Thrust bearing
42	1	Wormshaft bearing
43	1	Wormshaft bearing INA HK 3026
46	1	'O' Ring 200-258-4460
47	1	'O' Ring 200-532-4460
51	1	'O' Ring 200-346-4460
52	1	'O' Ring 200-336-4490
53	1	'O' Ring 200-006-4460
55	2	Oilseal Weston W15711827 R4
56	1	Oilseal Weston W11805939 R4
57	1	Oilseal (Torque plunger) 11M16/8/7B
59	1	Redcap
61	4	Skt capscrew 5/16" UNC x 1" LG
62	1	Sel lok pin 3/16" x 1 LG
63	1	Split pin 1/8" x 5/8" LG
64	1	Sel lok pin 3/32" dia x 1/2" LG
65	1	Skt setscrew 5/16" UNF x 3/8" LG
66	1	Skt setscrew yoke 5/16" UNC x 2" LG
68	2	Sel lok pin 1/16" x 3/8" LG
69	12	Skt capscrew 3/8" UNC x 1" LG
70	4	Skt capscrew 1/4" UNC x 3/4" LG
79	1	Hex steel locknut 5/16" UNC
84	1	Torque plunger FLP Shroud
86	3	Taper plug 1/2" BSPT
89	1	Cam return spring
120	1	Limit switch wheel
121	1	Spacer
122	1	Limit switch shaft
125	2	Spirol pin 1/8" dia x 5/8" LG
129	1	Torque plunger
147	1	Hand wheel retainer
150	2	Wavy washer 5/8" I/D Ref 5119
152	1	Extractor body
154	1	Dowty selon sealing washer
168	1	Hand auto finger spacer

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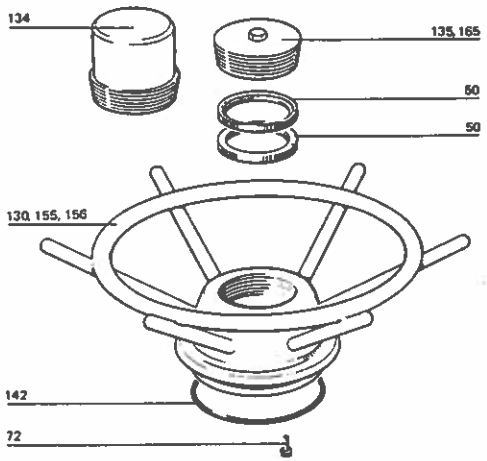
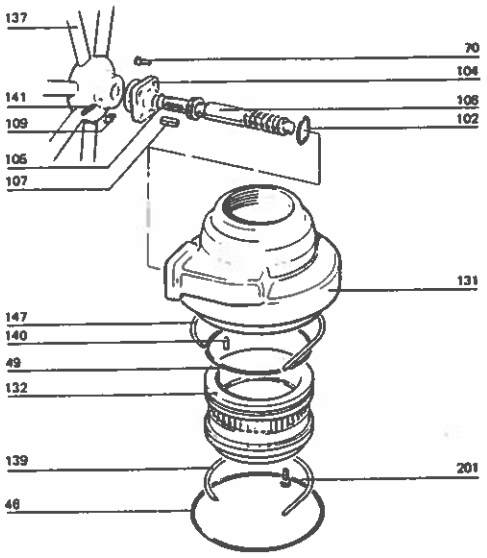
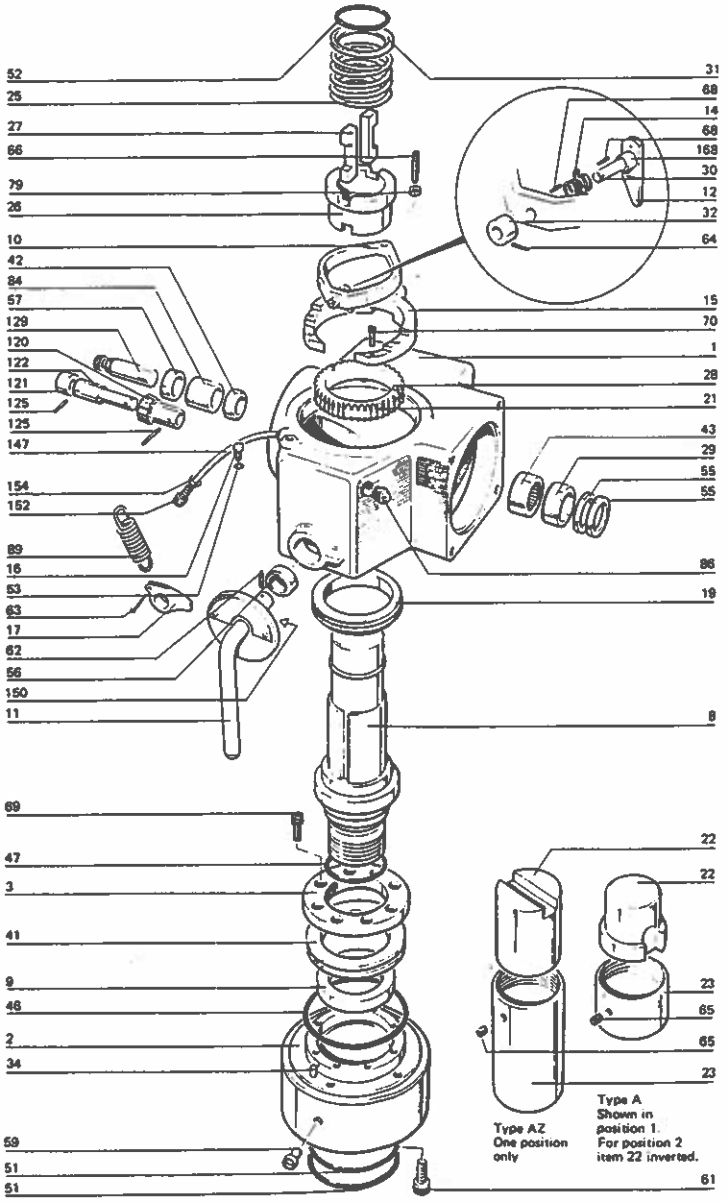
Handwheel assembly

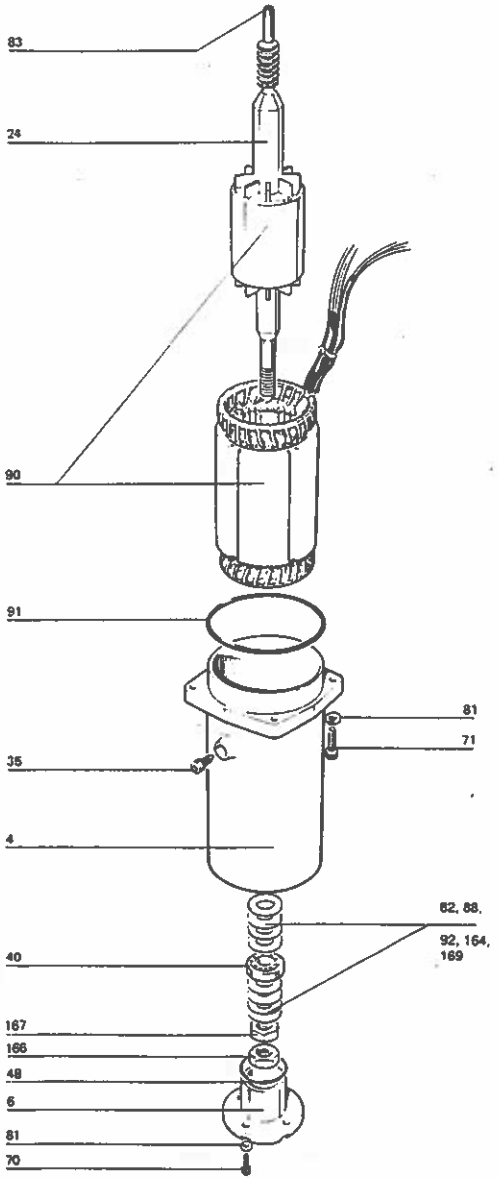




Gearcase/drive sleeve/thrust base



Motor



Item no.	Qty.	Component description
30A Top handwheel		
50	2	Oilseal Weston W39430 751-R4
72	2	Capscrew 5/16" UNC x 3/4" LG
130	1	Handwheel
155		
156		
134	1	Screwed cover tube
135	1	Screwed bung
165		
142	1	'O' Ring
30A Side handwheel		
46	1	'O' Ring 200-258-4460
49	1	'O' Ring 200-427-4460
70	4	Capscrew 1/4" UNC x 3/4" LG
102	1	'O' Ring 200-214-4460
104	1	End housing
105	1	'O' Ring 200-114-4460
106	1	Wormshaft
107	1	Key 3/16" x 3/16" x 1 1/8"
109	1	Grease nipple 1/8" BSP
13	1	Worm casing
132	1	Wormwheel
137	1	Handwheel
139	1	Wormwheel retainer
140	2	Spirol pin 5/16" dia x 1 1/4" LG
141	2	Socket setscrew 10-24 UNC x 1/2" LG
147	1	Handwheel retainer
201	2	Drive pin
30A Motor		
4	1	Motor cover
6	1	Motor end cap
24	1	Wormshaft. Only supplied with wormwheel (21)
35	2	Stator locking screw
40	1	Bearing SKF6204
48	1	'O' Ring 200-226-4460
70	4	Skt capscrew 1/4" UNC x 3/4" LG
71	4	Skt capscrew 1/4" UNC x 1 1/4" LG
81	8	Washer std 1/4" UNC
83	1	Ball 1/4" dia steel
82, 88 92, 164, 169	8	Disc spring and spacer (combinations vary according to output torque)
90	1	Stator rotor unit
91	1	'O' Ring 200-257-4460
16	1	Hex locknut
167	1	Hex locknut

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Spare parts list for 'A' Range actuators

40A actuator Mechanical assemblies

Catalog section 5
Publication number AE5/5.4
Date of issue 5/93

Item no.	Qty.	Component description
40A Gearcase		
1	1	Gearcase
2	1	Thrust base
3	1	Thrust ring
8	1	Centre column
9	1	Bearing stop ring
10	1	Yoke
11	1	Hand auto lever
12	1	Hand auto finger
14	1	Finger return spring
15	1	Thrust pad
16	1	Locating pin
17	1	Hand auto cam
18	1	Washer
19	1	Limit switch worm
21	1	Wormwheel
22	1	Drive bush (Type A or AZ)
23	1	Drive bush retainer (Type A or AZ)
25	1	Clutch spring
26	1	Clutch ring
27	2	Clutch key
28	2	Drive pin
29	1	FP shroud (Wormshaft)
30	1	Finger spindle
31	1	Clutch spring washer
32	1	Hand auto roller
34	2	Heavy duty spirol pin 5/16" x 1" LG HBK
41	1	Bearing (Centre column/Thrust base) SKF 51120
42	1	Wormshaft bearing
43	1	Wormshaft bearing INA MK 3520
46	1	'O' Ring 200-262-4460
47	1	'O' Ring 200-532-4460
51	2	'O' Ring 200-349-4460
52	1	'O' Ring 200-338-4460
55	1	Oilseal Weston W18513727-R4
56	1	Oilseal Weston W11805939-R4
57	1	Oilseal (Torque plunger)
59	1	Redcap
62	1	Steel sel lok pin 05 x 25 LG
63	1	Steel split pin 03x 12.7 LG
64	1	Steel sel lok pin 02.4 x 13
65	1	Steel skt hd setscrew knurled
66	1	Skt setscrew yoke 5/16"-UNC x 2" LG
67	3	Skt setscrew 10-24 UNC x 3/8"
68	2	Steel sel lok pin 01.5 x 10
69	12	Steel skt hd capscrew 3/8"-UNC x 1 1/4"
70	4	Steel skt hd capscrew
79	1	Steel locknut 5/16"-UNC
86	3	Taper plug 1/2" BSP
89	1	Cam return spring
98	1	Spacer
125	1	Limit switch wheel
126	1	Limit switch shaft
127	2	Spirol pin 1/8" dia x 5/8" LG
136	1	Torque plunger
147	1	Hand wheel retainer
152	1	Extractor body
154	1	Dowty selon sealing washer 269-703-1732

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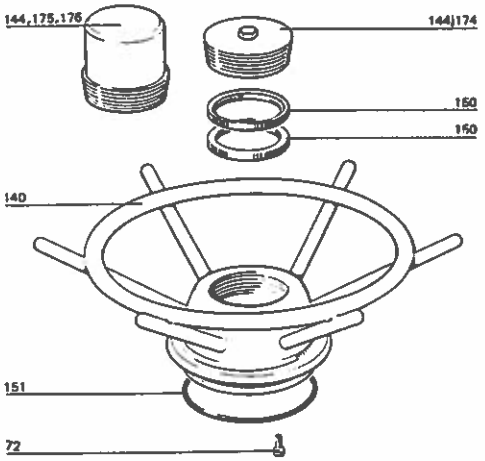
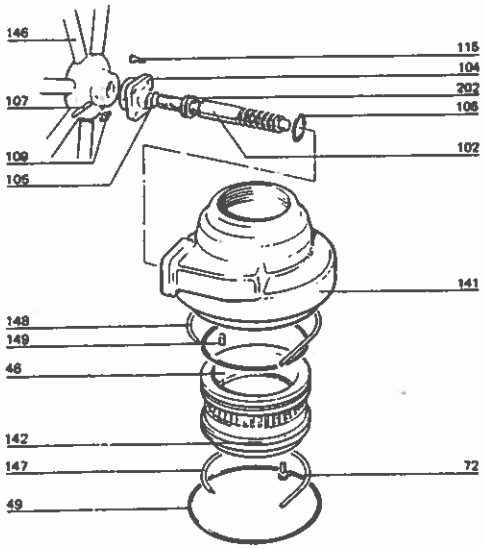
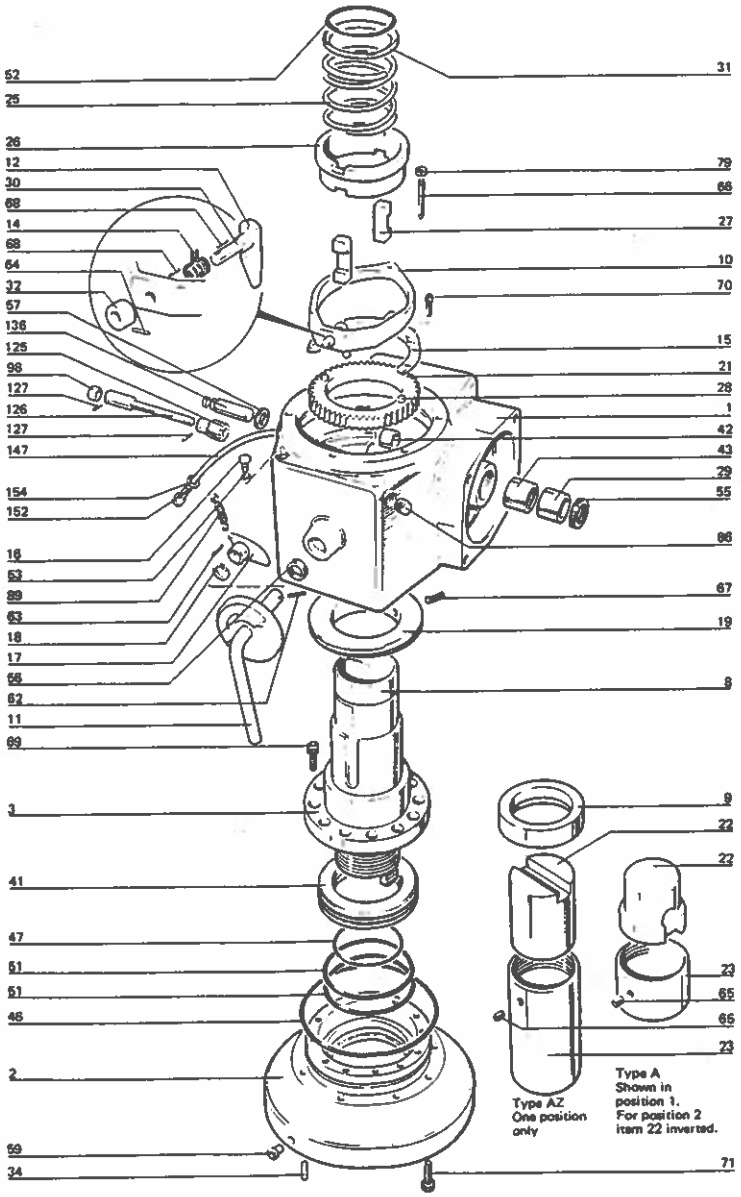
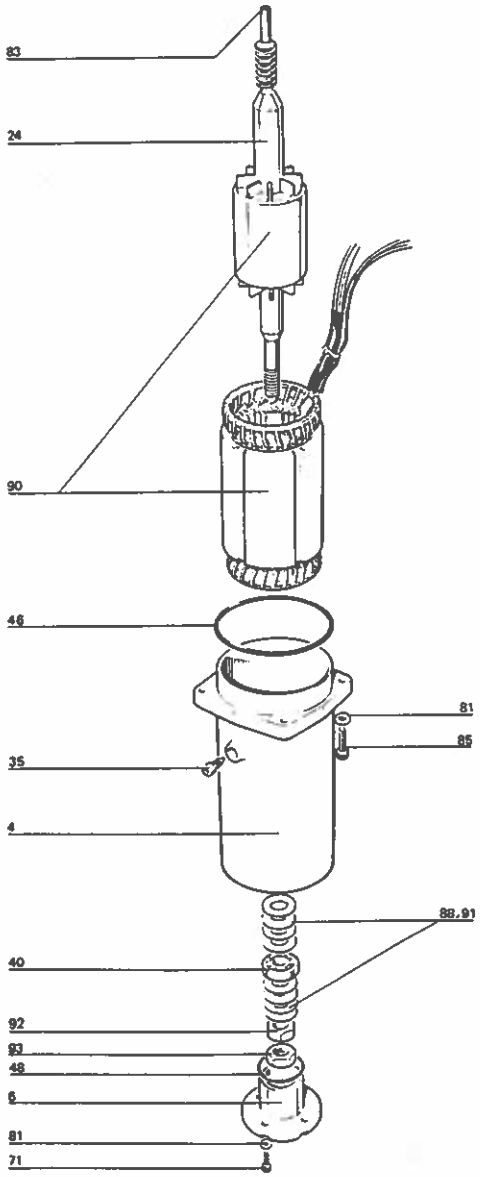




Gearcase/drive sleeve/thrust base



Motor



Item no.	Qty.	Component description
40A Top handwheel		
72	2	Capscrew M8 x 1.25" x 20 LG
140	1	Handwheel
144,174	1	Screwed bung
144,175		
176	1	Screwed cover tube
150	2	Oil seal Weston WE14333451-R4
151	1	'O' Ring 200-440-4460
40A Side handwheel		
46	1	'O' Ring 200-262-4460
49	1	'O' Ring 200-429-4460
72	2	Capscrew M8 x 1.25" x 20 LG
102	1	Wormshaft
104	1	End housing
105	1	'O' Ring 200-213-4460
106	1	'O' Ring 200-222-4460
107	1	Sel lock pin 5/16" dia x 2 1/2" LG
109	1	Grease nipple 1/8" BSP
1	4	Skt hd capscrew 1/4" UNC x 1" LG
141	1	Worm casing
142	1	Wormwheel
146	1	Handwheel
147	1	Handwheel retainer
148	1	Wormwheel retainer
149	2	Spirol pin 5/16" dia x 1 1/4" LG
40A Motor		
4	1	Motor cover
6	1	Motor end cap
24	1	Wormshaft. Only supplied with wormwheel (21)
35	2	Steel stator locking screw
40	1	Motor end cap bearing SKF6306-2RS
46	1	'O' Ring 200-262-4460
48	1	'O' Ring 200-235-4460
71	4	Steel skt capscrew 5/16" UNC x 1 LG
81	8	Steel washer 8mm
83	1	Steel ball 1/4" dia
85	4	Steel skt hd capscrew 5/16" UNC x 1 1/4" LG
88, 91		Disc spring and spacers (combinations vary according to output torque)
90	1	Stator rotor unit
92	1	Hex locknut
93	1	Hex locknut

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Spare parts list for 'A' Range actuators

70/90/95A actuators Mechanical assemblies

Catalog section 5
Publication number AE5/5.5
Date of issue 7/93

Item no.	Qty.	Component description
70/90/95A Gearcase		
1	1	Gearcase
2	1	Thrust base
3	1	Gearcase base
8	1	Centre column
9	1	Bearing stop ring
10	1	Yoke
11	1	Hand auto lever
12	1	Finger assembly
14	1	Finger return spring
15	1	Thrust pad
16	1	Locating pin
17	1	Hand auto cam
19	1	Limit switch worm
21	1	Wormwheel
22	1	Drive bush (Type A or AZ)
23	1	Drive bush retainer (Type A or AZ)
25	1	Clutch spring
26	1	Clutch ring
27	2	Clutch key
28	2	Drive pin
29	1	Shroud
30	1	Finger spindle
31	1	Washer
32	1	Roller
34	2	Dowel pin 7/16" x 1 1/4" LG
41	1	Thrust bearing SKF 51222
42	1	Needle bearing INA HK 18/16 18 x 24 x 16
43	1	Needle bearing INA HK 45/20 45 x 52 x 16
44	1	'O' Ring
45	1	'O' Ring 200-262-4460
47	1	'O' Ring 200-540-4460
51	1	Oilseal W57547550R4
52	1	'O' Ring 207-221-4490
53	1	'O' Ring 200-006-4460
55	2	Oilseal (Wormshaft) INA 945 x 52 x 4
56	1	Oilseal Weston W11206225
57	2	Oilseal (Torque plunger) INA G13 x 19 x 3
59	1	Redcap
62	1	Spirol pin 1/4" dia x 1 1/4" LG
63	1	Split pin 1/8" dia x 5/8" LG
64	1	Spirol pin 1/16" dia x 5/8" LG
65	1	Socket setscrew 5/16" UNF x 5/8" LG
66	1	Skt setscrew 5/16" UNC x 1 3/4" LG
67	3	Skt setscrew 10-24 UNC x 5/16" LG
70	8	Capscrew 5/16" UNC x 3/4" LG
72	2	Hand drive screw
79	1	Hex full nut 5/16" UNC
82	1	Crinkle washer 5/8"
86	3	Taper plug 1/2" BSP
89	1	Hand auto return spring
95	1	Sel-lok pin 3/32" dia x 5/8" LG
96	1	Sel-lok pin 3/32" dia x 1/2" LG
112	1	Limit switch shaft
113	1	Limit switch wheel
115	1	Torque plunger

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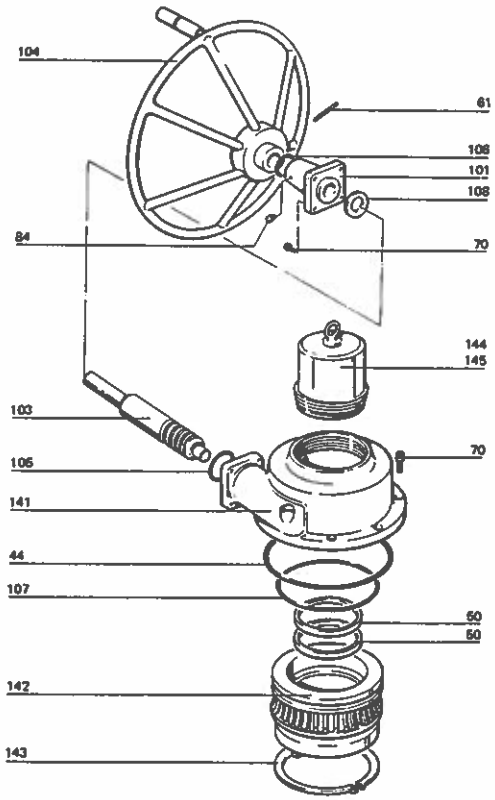
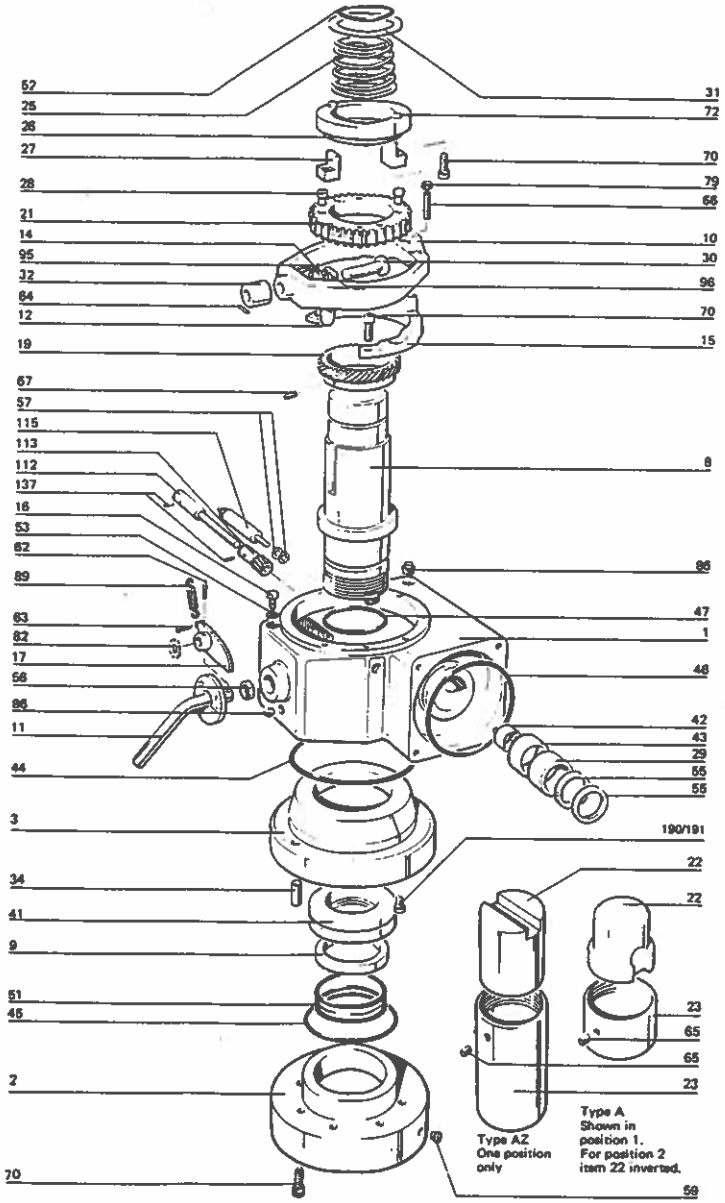
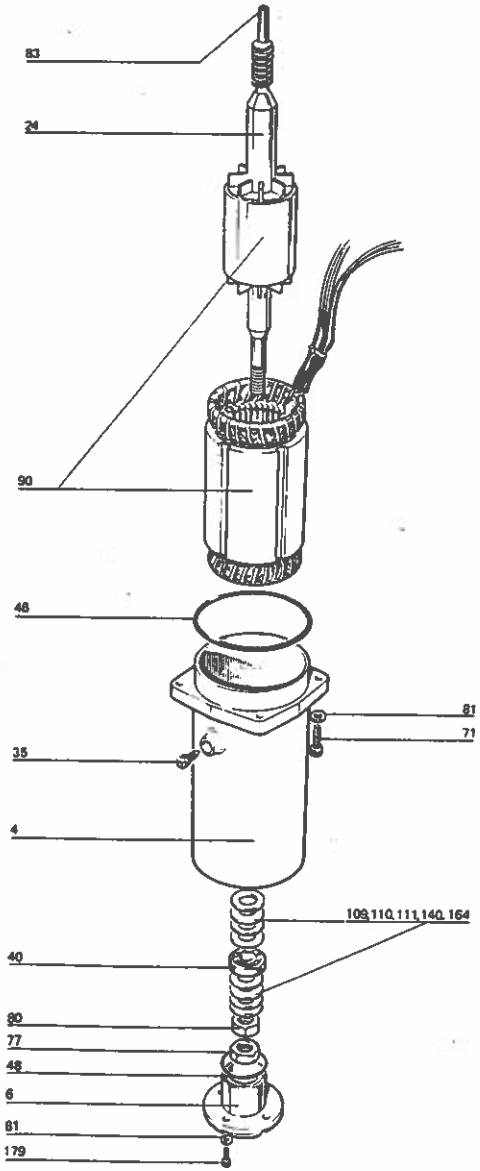
Handwheel assembly



Gearcase/drive sleeve/thrust base



Motor



Item no.	Qty.	Component description
70/90/95A Handwheel		
44	1	'O' Ring
50	2	Oilseal W45037550 R4
61	1	Sel-lok spring pin 5/16" dia x 2 1/2" LG
70	11	Capscrew 5/16" UNC x 8" LG
84	1	Grease nipple 1/8" BSP
101	1	End cap
103	1	Wormshaft
104	1	Handwheel
105	1	'O' Ring 200-032-4460
106	1	'O' Ring
107	1	'O' Ring
108	1	Thrust washer
141	1	Side handwheel
142	1	Wormwheel
143	1	Circlip
144	1	Screwed cover tube
145	1	Screwed bung
'90/95A Motor		
4	1	Motor cover
6	1	Motor end cap
24	1	Wormshaft Only supplied with Wormwheel (21)
35	2	Stator locking screw
40	1	Bearing 30 x 72 x 19
46	1	'O' Ring
48	1	'O' Ring 200-041-4460
71	4	Capscrew 5/16" UNC x 1 1/4" LG
77	1	Hex lock nut
80	1	Hex lock nut
81	8	Steel washer 5/16" dia
83	1	5/16" dia steel ball
90	1	Stator rotor unit
109, 110 111, 140 164		Disc spring and spacer (Combinations vary according to output torque)
179	4	Capscrew 5/16" x 7/8" LG
190	6	Capscrew 5/16" UNC x 1" LG
191	6	Single coil spring washer 5/16" ID

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Spare parts list for 'A' Range actuators

Syncropak housing Electrical assemblies

for 'A' Range actuators type 1200 and 1400 series

Catalog section 5
Publication number AE5/5.6
Date of issue 3/91

Item no.	Qty.	Component description
1	1	Syncropak body
2	1	Terminal cover EP,FLP, UK, WT, EP, CSA, USA
3	1	Terminal cover WT, UK only
4	1	Pushbutton cover
5	1	Front plate
6	1	Side mounting chassis
7	1	Selector locking latch
8	1	Control knob including spindle
9	1	Selector knob including spindle
12	2	Power terminal (Earth)
16		Terminal nut 6-32 UNC
17		Terminal nut 10-24 UNC
18		Plain washer 2BA x 3/8" OD
19		Single coil spring washer 2BA
21	1	Control switch striker
22	1	Control knob return clip
24	1	External circlip
25	1	'O' Ring seal
27	1	Dust shroud (Control knob)
28	1	Control knob return spring - compression
29	1	PVC Dust shroud (selector knob)
30	1	Selector switch spring
31	2	'O' Ring
32	1	Compression spring
33	1	3/16" Dia steel ball
34	1	Selector cam
36	1	Spirol pin
37	1	Spirol pin MBK 1/4" Ø x 3/4" LG
38A	2	'O' Ring seal
38B	1	'O' Ring seal 200-562-4460
41	1	Chassis restraint wire
42	1	Power terminal screen
43	1	Transformer take off terminal screen
44	1	Earth label, brass
45	1	Spacer
48	1	Skt head capscrew
49	8	Skt hd 'C' sunk screen 1/4" UNC x 1" LG
50	4	Skt head 1/4" UNC 1" LG
55	10 or 12	Taptite Pan head screw 6-32 UNC x 7/8" LG
57	5	Skt head capscrew 10-24 UNC x 1/2" LG
59	1	Plain washer
61	1	Chassis mounting strap
68	1	Heavy duty switch mech loom
69	1	Transformer, terminal assembly
70	3	Fuseholder (Belling Lee 1744)
71	4	Fuse link 500 MA
72	3 or 4	Burgess switch (TK5C 1485)
74		Single coil spring washer 4BA
75	2	Transformer mounting strip
78		Plain washer 4BA
91	1	Reversing contactor on baseplate
95	1	Code card
96	1	Terminal block FLP
97	1	Terminal block WT/EP
115		Locknut steel 10-24 UNC
120B	1	'O' Ring seal
121	1	Syncropak adaptor (40-95A actuators)
169	1	Lamp holder
170	1	Lamp holder
171	1	Ceramic resistor (heater)
172	1	Lamp 12v 2.2 w
175		Shakeproof washer 2BA
180	1	Antifriction washer
181	1	Antifriction washer

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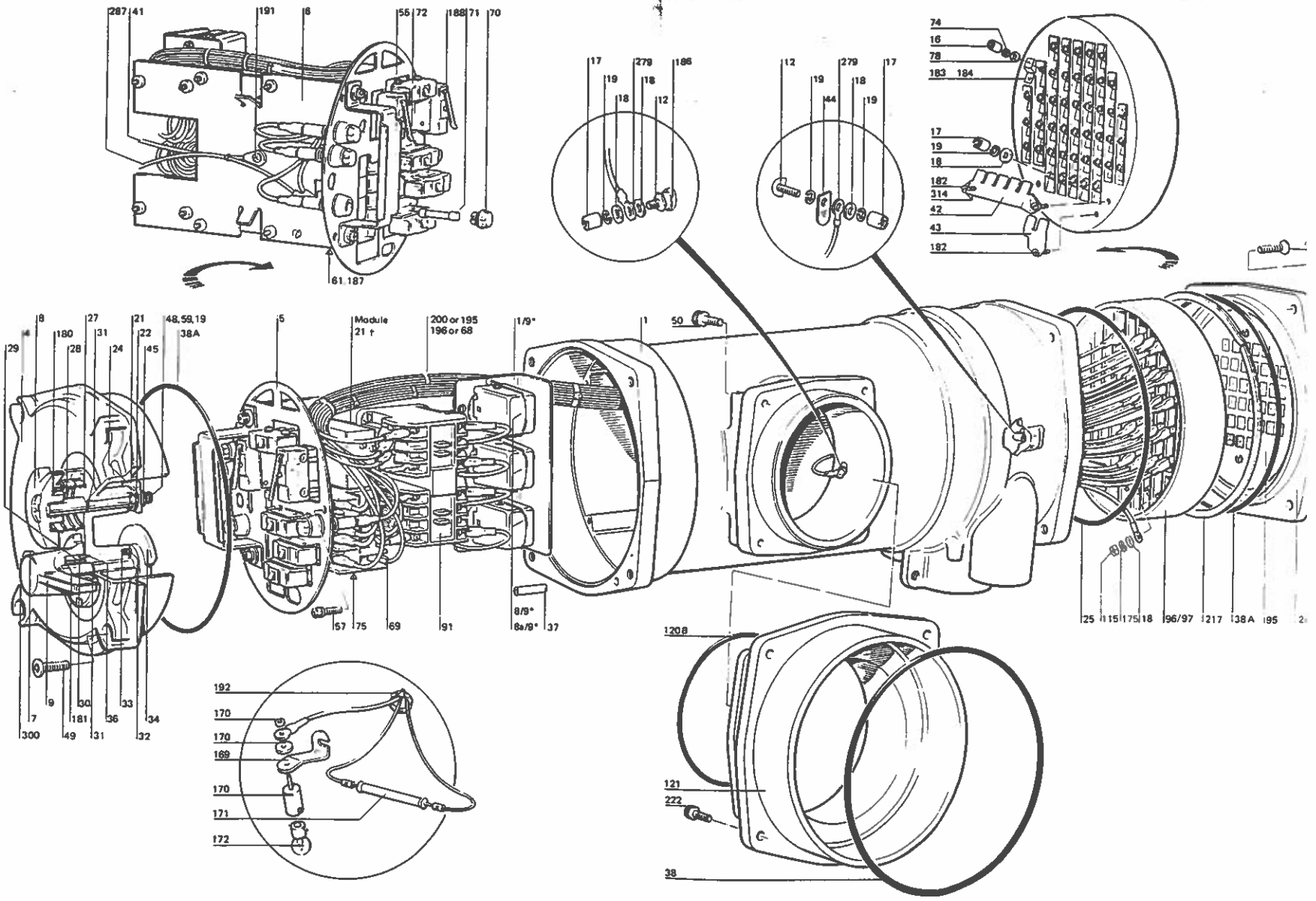
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12 19 279 18 17 44 19
74 16 78 183 184 17 19 18 182 314 42 43 182
29 4 8 180 28 27 31 24 21 22 45 48,59,19 38A
5
Module 21 †
200 or 195 196 or 68
1/9*
1 50
57 75 69 91 8/9* 8a/9* 37
25 115 175 18 96/97 217 38A 195
9 30 33 34 7 181 36 300 49 31 32
192 170 170 169 170 171 172
120B 121 222 38

Item no.	Qty.	Component description
182		Slotted fil hd screw 6-32 x 1/4" LG
183 or 184		Terminal link
186	1	Special spacer
187	1	Transformer insulating strip
188	2	Burgess switch (TK 5K)
191		Pan head taptite screw 6-32 x 3/8" LG
192	6	Panduit Sta-Straps
195	1	Basic loom CSA
196	1	CSA Switch mech loom
200	1	Basic loom (Heavy duty)
217	1	Wellworthy spirolox retaining ring
222	4	Skt head capscrews 5/16" UNC x 1" LG
279	2	Earth link wire
287	1	Earth link
300	1	Spirol pin
314	2	6BA Nylon washer
Modules		
1/9*	1	Relay mounting plate
"	2	Interposing relay (DC)
3*	1	Monitor relay (AC)
21†	1	Phase rotation discriminator

*Module 9 - Relays
8/9 - Interposing relays on wiring diagrams
1410 or 1411 - 42, 45, 52, 55 only
8a/9-Monitor relay on wiring diagrams
1410 or 1411 - 41, 45, 51, 55 only

†Module 21 - Phase Discriminator on wiring diagrams
1410 or 1411 - 50, 51, 52, 55 only

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Spare parts list for 'A' Range actuators

Syncropak housing Electrical assemblies

for 'A' Range actuators type 1600 Mk 2 series

Catalog section 5
Publication number AE5/5.6.1
Date of issue 8/90

Module no.	Qty.	Description
6A/3	1	Complete Syncropak (casting and chassis)*
6A/4	1	Complete Syncropak casting and chassis (Cenelec enclosure)*
6B/3	1	Slide in chassis complete with pushbuttons and PCB*
6B/4	1	Printed circuit board (PCB) and base plate*
6C/2	1	Contactor and base plate*
6F/2	1	Push button cover*
6F/4	1	Switches and loom for push button cover*
6F/5	1	Push button cover (Cenelec enclosure)*
6F/6	1	Red selector knob/dust shroud/nylon cam etc*
6F/7	1	Black local-remote selector knob/shaft/cam etc*

*Variable item

Item no.	Qty.	Component description
1	1	Syncropak body*
2	1	Terminal cover*
25	1	'O' ring seal, terminal block
38A	2	'O' ring seal, terminal cover and push button cover
38A	1	'O' ring seal, Syncropak adaptor for 40A actuator only
38B	1	'O' ring seal, Syncropak adaptor for 70A - 95A
49	8	Fixing screws, terminal cover and push button cover*
50	4	Fixing screws, Syncropak body*
96	1	Terminal block*
120B	1	'O' ring seal, Syncropak body
121	1	Syncropak to gearcase adaptor 40A - 95A actuator
217	1	Terminal block retaining ring
222	4	Fixing screws, gearcase adaptor to gearcase 40A 95A actuators*
255	1	Intermediate terminal block (Cenelec enclosures only)
386	4	Fuses 500 mA 20mm long
391	1	Fuse 800 mA 20mm long

(Item numbers as per LOP 119)
*Variable item

To ensure compatability, when enquiring for or ordering spare parts the actuator serial number size, wiring diagram must be given.

The 1600 series Mk 2 Syncropak module can be updated to the current model. Please refer to Rotork.

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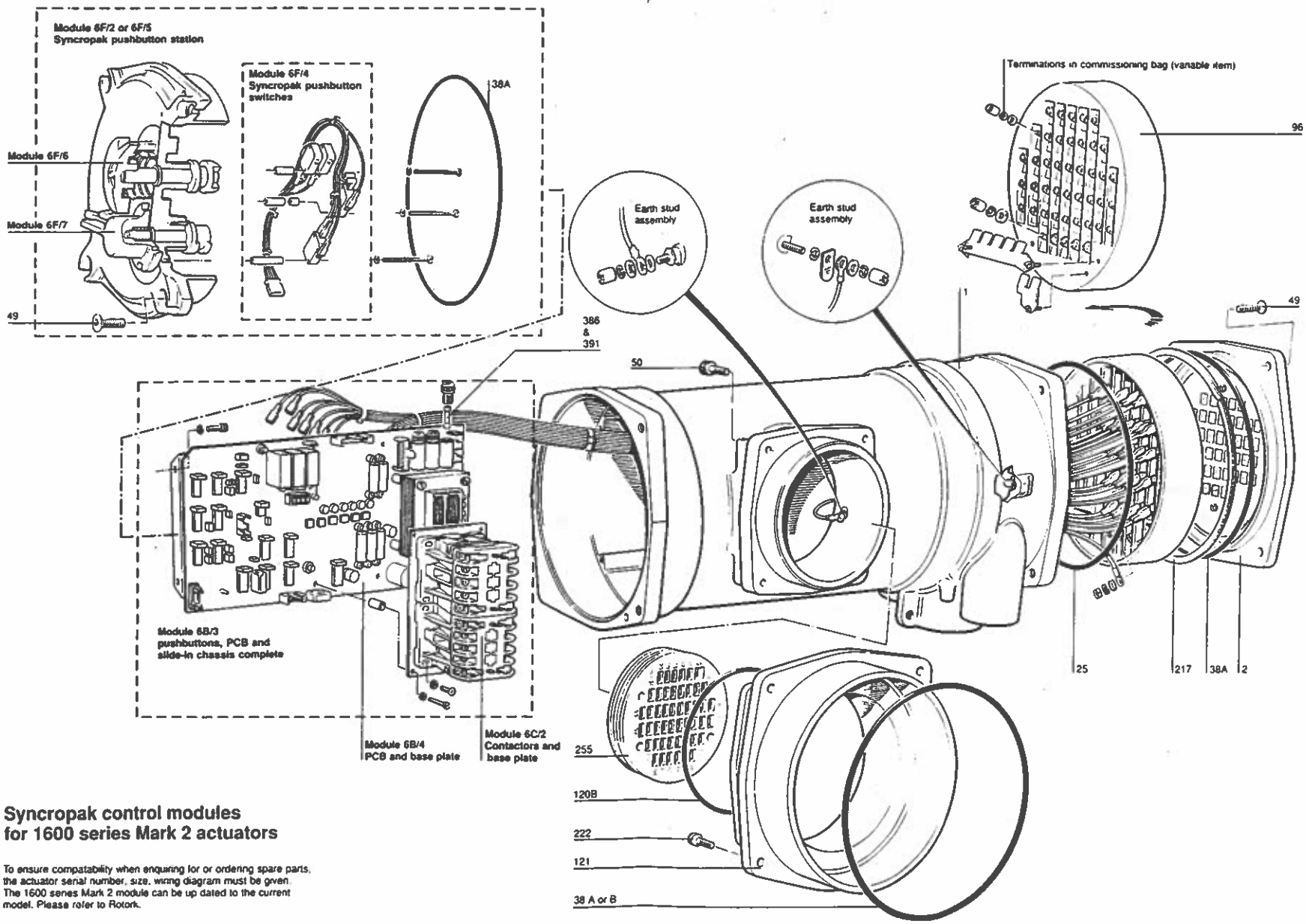

Syncropak control modules for 1600 series Mark 2 actuators

To ensure compatability when enquiring for or ordering spare parts, the actuator serial number, size, wiring diagram must be given. The 1600 series Mark 2 module can be up dated to the current model. Please refer to Rotork.

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Spare parts list for 'A' Range actuators

Syncropak housing Electrical assemblies

for 'A' Range actuators type 1600 Mk 4 series

Catalog section 5
Publication number AE5/5.6.2
Date of issue 8/90

Module no.	Qty.	Description
6A/3	1	Complete Syncropak (castings and chassis)*
6A/4	1	Complete Syncropak castings and chassis (Cenelec enclosure)*
6B/5	1	Starter chassis*
6B/6	1	Main printed circuit board *
6B/7	1	Remote control printed circuit board*
6C/3	1	Contactor and base plate*
6D/2	1	Power module (Transformer and fuses)*
6F/3	1	Push button cover*
6F/4	1	Push button cover switches and loom*
6F/5	1	Push button cover (Cenelec enclosure)*
6F/6	1	Red selector knob/dust shroud/nylon cam etc.*
6F/7	1	Black local-remote selector knob/shaft/cam etc*

*Variable item

Item no.	Qty.	Component description
1	1	Syncropak body*
2	1	Terminal cover*
4	5	Fuse 1.25" x .25" 250 mA anti-source
25	1	'O' ring seal, terminal block
38A	2	'O' ring seal, terminal cover and push button cover
38A	1	'O' ring seal, Syncropak adaptor for 40A actuator only
38B	1	'O' ring seal, Syncropak adaptor for 70A - 95A
49	8	Fixing screws, terminal cover and push button cover*
50	4	Fixing screws, Syncropak body*
96	1	Terminal block*
120B	1	'O' ring seal, Syncropak body
121	1	Syncropak to gearcase adaptor 40A - 95A actuator*
217	1	Terminal block retaining ring
222	4	Fixing screws, gearcase adaptor to gearcase 40A 95A actuators*
255	1	Intermediate terminal block (Cenelec enclosures only)

(Item numbers as per LOP 180)

*Variable item

To ensure compatability, when enquiring for or ordering spare parts the actuator serial number size, wiring diagram must be given.

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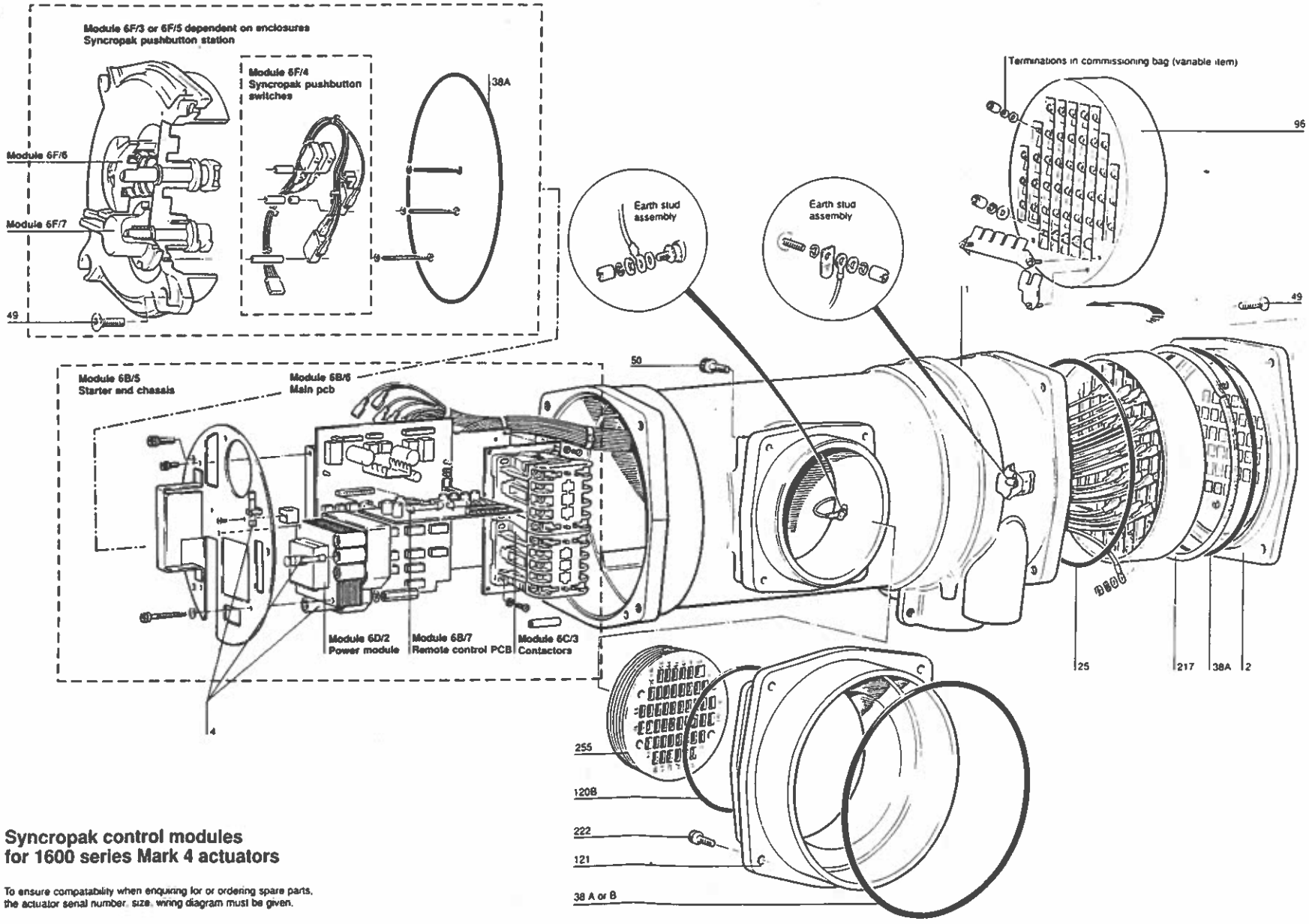

Syncropak control modules for 1600 series Mark 4 actuators

To ensure compatability when enquiring for or ordering spare parts, the actuator serial number, size, wiring diagram must be given.

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Spare parts list for 'A' Range actuators

Syncropak housing Electrical assemblies

for 'A' Range actuators type 1600 Mk 5 series

Catalog section 5
Publication number AE5/5.6.3
Date of issue 1/92

Module no.	Qty.	Description
6A/3	1	Complete Syncropak (castings and chassis) UNC*
6A/4	1	Complete Syncropak (castings and chassis) Cenelec enclosure*
6A/6	1	Complete Syncropak (castings and chassis) watertight metric*
6B/5	1	Starter chassis*
6B/6	1	Main printed circuit board *
6C/3	1	Contactors and base plate*
6D/2	1	Power module (Transformer and fuses)*
6F/3	1	Push button cover (UNC)
6F/4	1	Switches and loom for push button cover
6F/5	1	Push button cover (Cenelec and watertight metric)
6F/6	1	Red selector knob/dust shroud/nylon cam etc.*
6F/7	1	Black local-remote selector knob/shaft/cam etc*
6G/1	1	Folomatic PCB
6G/2	1	Combined folomatic and current position transmitter PCB
6G/3	1	Pakscan PCB*
6G/4	1	Interrupter timer PCB

*Variable item

Item no.	Qty.	Component description
1	1	Syncropak body (casting only)*
2	1	Terminal cover*
4	3	Fuses QF1, 2 and 3 1.25" x .250". 250 mA anti-surge (150mA if over 550V)
4	1	Fuse QF4 1.25 x .250". 500mA anti-surge
25	1	'O' ring seal, terminal block
38A	2	'O' ring seal, terminal cover and push button cover
38A	1	'O' ring seal, Syncropak adaptor for 40A actuator only
38B	1	'O' ring seal, Syncropak adaptor for 70A - 95A
49	8	Fixing screws, terminal cover and push button cover*
50	4	Fixing screws, Syncropak body*
96	1	Terminal block*
120B	1	'O' ring seal, Syncropak body
121	1	Syncropak to gearcase adaptor 40A - 95A actuator*
217	1	Terminal block retaining ring
222	4	Fixing screws, gearcase adaptor to gearcase 40A 95A actuators*
255	1	Intermediate terminal block (Cenelec enclosures only)

(Item numbers as per LOP 217)

*Variable item

To ensure compatability, when enquiring for or ordering spare parts the actuator serial number size, wiring diagram must be given.

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USA, Philadelphia	(215) 696 7302	(215) 696 7354
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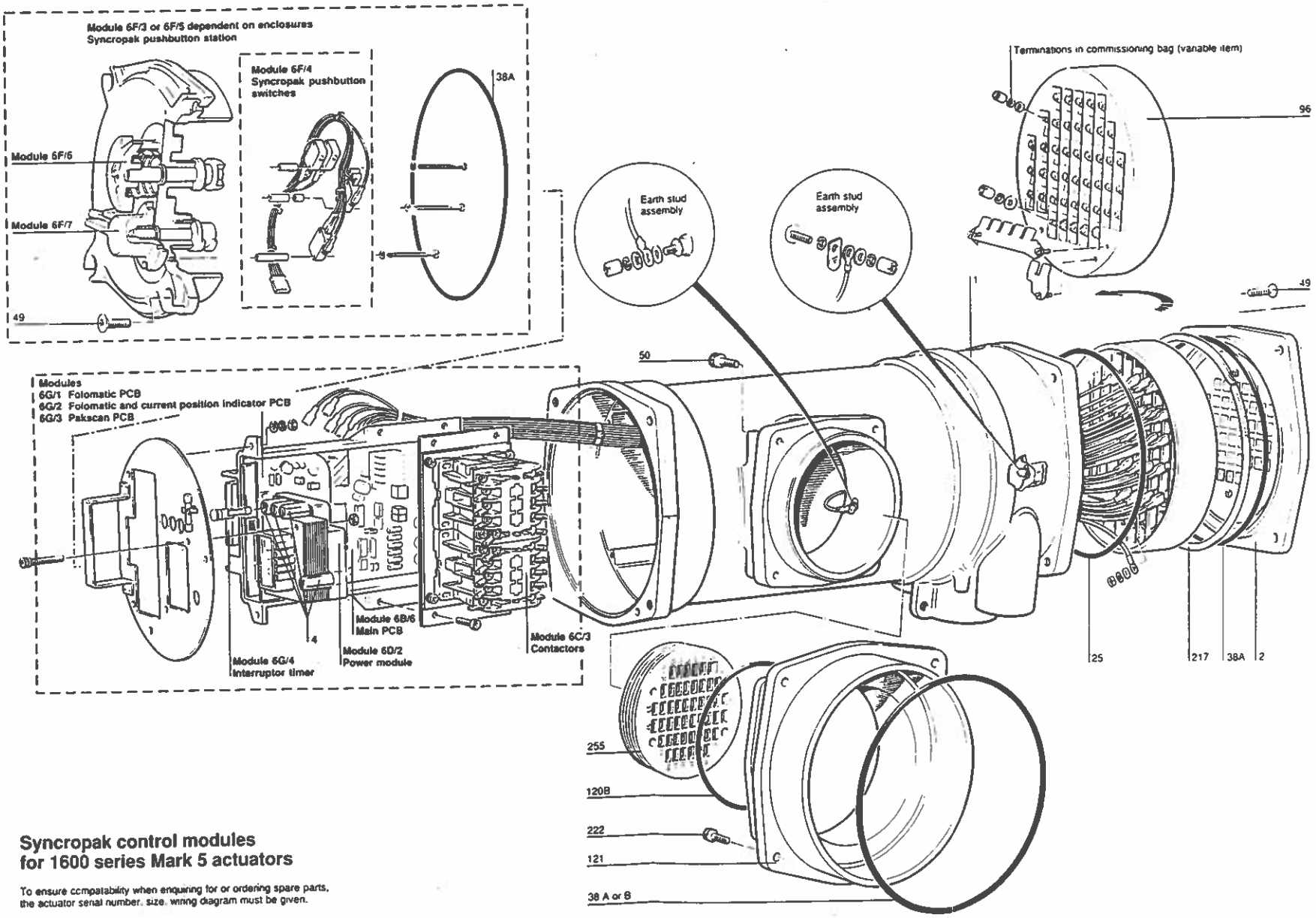

Syncropak control modules for 1600 series Mark 5 actuators

To ensure compatability when enquiring for or ordering spare parts, the actuator serial number, size, wiring diagram must be given.

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Spare parts list for 'A' Range actuators

Syncropak housing Electrical assemblies

for 'A' Range actuators type 1600 Mk 5 series

Catalog section 5
Publication number AE5/5.6.3
Date of issue 1/92

Module no.	Qty.	Description
6A/3	1	Complete Syncropak (castings and chassis) UNC*
6A/4	1	Complete Syncropak (castings and chassis) Cenelec enclosure*
6A/6	1	Complete Syncropak (castings and chassis) watertight metric*
6B/5	1	Starter chassis*
6B/6	1	Main printed circuit board *
6C/3	1	Contactors and base plate*
6D/2	1	Power module (Transformer and fuses)*
6F/3	1	Push button cover (UNC)
6F/4	1	Switches and loom for push button cover
6F/5	1	Push button cover (Cenelec and watertight metric)
6F/6	1	Red selector knob/dust shroud/nylon cam etc.*
6F/7	1	Black local-remote selector knob/shaft/cam etc*
6G/1	1	Folomatic PCB
6G/2	1	Combined folomatic and current position transmitter PCB
6G/3	1	Pakscan PCB*
6G/4	1	Interrupter timer PCB

*Variable item

Item no.	Qty.	Component description
1	1	Syncropak body (casting only)*
2	1	Terminal cover*
4	3	Fuses QF1, 2 and 3 1.25" x .250". 250 mA anti-surge (150mA if over 550V)
4	1	Fuse QF4 1.25 x .250". 500mA anti-surge
25	1	'O' ring seal, terminal block
38A	2	'O' ring seal, terminal cover and push button cove
38A	1	'O' ring seal, Syncropak adaptor for 40A actuator only
38B	1	'O' ring seal, Syncropak adaptor for 70A - 95A
49	8	Fixing screws, terminal cover and push button cover*
50	4	Fixing screws, Syncropak body*
96	1	Terminal block*
120B	1	'O' ring seal, Syncropak body
121	1	Syncropak to gearcase adaptor 40A - 95A actuator*
217	1	Terminal block retaining ring
222	4	Fixing screws, gearcase adaptor to gearcase 40A 95A actuators*
255	1	Intermediate terminal block (Cenelec enclosures only)

(Item numbers as per LOP 217)

*Variable item

To ensure compatability, when enquiring for or ordering spare parts the actuator serial number size, wiring diagram must be given.

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Spare parts list for 'A' Range actuators

Syncroset housing Electrical assemblies

Catalog section 5
Publication number AE5/5.7
Date of issue 1/91

Item no.	Qty.	Component description
1	1	Syncroset body
2	1	Cover plate FLP/EP/CSA
3	1	Cover plate WT
6	1	Earth terminal
10		Terminal nut 6-32 UNC
11		Terminal nut 10-24 UNC
12		Plain washer 2BA x 1/8" OD
13		Spring washer 2BA
15		Spring washer 4BA
16		Plain washer 4BA
17	1	Power terminal screen
18	1	'O' Ring
28a or b	1	'O' Ring
31	1	Earth label
32	2	Fill head slotted screw 6'-32 UNC x 1/4" LG
36	4	Skt hd Capscrew 1/4" UNC x 1" LG
37	4	Skt hd Capscrew 5/16" UNC x 1" LG
38	1	Adaptor (40A - 95A only)
39 a or b	1	'O' Ring 200-249-4460
42	4	Spring steel washer 1/4" dia.
43	1	Loom (thermostat) Only supplied if actuator serial number specified
49	4	Skt hd 'C' sunk screw 1/4" UNC x 1" LG
63	1	Ceramic heater
72		Terminal link
95	1	Code card
108	1	Terminal bung WT/EP
109	1	Terminal bung FLP
217	1	Wellworthy spirolox retaining ring
208	1	Loom (switch mech. motor) Only supplied if actuator serial number is specified.
314	2	6BA Nylon washer

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Spare parts list for 'A' Range actuators

Switch mechanism and Add-on-Pak 1 Electrical assemblies

Catalog section 5
Publication number AE5/5.8
Date of issue 10/90

Module numbers	Component description
Basic switch mechanism	
3a	Switch mechanism
3b	Switch banks (2 sets of 3)
3c	Switch mechanism complete with cover and 'O' ring
3d/2	Indicator dial, 'O' ring and screws
Add-on-Pak 1	
8a	Add-on-Pak complete with cover and 'O' ring
8b	Switch banks (2 sets of 3)
8c	Potentiometer and gears

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Canada, Toronto	(905) 602 5665	(905) 602 5669
Canada, Vancouver	(604) 526 9948	(604) 526 9986
China, Beijing	(1) 5137550	(1) 5240003
China, Shanghai	(21) 2198185	(21) 2197311
France, Paris	(1) 48 35 44 99	(1) 48 35 42 54
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Spare parts list for 'A' Range actuators

AR actuators

Center colum and drive bush for 40/70/90/91 AR actuators

Catalog section 5
Publication number AE5/5.9
Date of issue 11/90

Item no.	Qty.	Component description
2	1	Mounting base
8	1	Centre column
9	1	Friction washer
19	1	Limit switch norm
22	1	Type AR drive bush
23	1	Circlip
34	2	Spirol pin
41	2	Spirol pin
44	1	'O' Ring
51	2	Oilseal
67	3	Skt setscrew 10-24 UNC x 5/16" LG
70		Capscrew

Note:
When ordering parts, specify actuator size:
40AR, 70AR, 90AR or 91AR.

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D I G I T A L P A N E L M E T E R S

Model PD690 Options Instruction Manual

inearization Option (-12 in part number)
- 11 Point User Calibration
- Square Root Extraction

PD174 2 Relays (-14)

PD175 Isolated 4-20 mA Output (-15)

PD176 2 Relays + 4-20 mA Output (-16)

PD177 4 Relays (-17)

PD178 4 Relays + 4-20 mA Output (-18)

The PD690 microprocessor-based digital process meter can be equipped with options for linearization, relay contacts and isolated 4-20 mA transmitter output. These options may be combined in any configuration to satisfy a wide variety of applications. In fact, a fully loaded model PD690-3-12-18 includes linearization, 4 relays and isolated 4-20 mA transmitter output.

The linearization option has two modes of operation for either 11 point user selectable calibration or square root extraction.
The 11 point user calibration will display non-linear signals like volume in a round horizontal tank by lowing the user to input up to 11 calibration points nd corresponding displays.
The square root extraction feature will display flow rate by extracting the square root of a signal from a differential pressure transmitter. This option also has a user selectable low flow cutoff feature to give a reading of zero when the flow rate drops below a user-set point.

The PD690 is available with either 2 or 4 SPDT hard contact relays, rated at 5 Amp @ 240 VAC. Any relay may be programmed for High or Low trip action and 0-100% deadband. The relays may be reset either automatically or automatically + manually via the front panel ACK button or a user installed switch connected to terminals at the rear of the meter.

The PD690 can also be equipped with an isolated 4-20 mA output signal option that can be programmed to produce a 4-20 mA output signal for virtually any input. The 4-20 mA output signal can be powered either by the internal PD690 power supply or by an external power supply.

Removable screw terminal blocks are provided for all onnections.

All options are field installable except linearization.

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SPECIFICATIONS

RELAYS

RATING: 2 or 4 relays; SPDT (form C). The contacts are rated 5 Amp @ 30 VDC or 5 Amp @ 250 VAC resistive load; 1/14 HP @ 125 / 250 VAC for NC contacts and 1/10 HP @ 125 / 250 VAC for NO contacts, inductive load.
RESET: User select.
1. Automatically when the input passes the reset point.
2. Automatically + manually (via user supplied switch or front panel ACK button). Manual reset resets all manually resetable relays, (that have been tripped).

FAILSAFE OPERATION: The relay coils are energized in the non-alarm condition. In the case of a power failure, the relays will go to the alarm state.
AUTO INITIALIZATION: When power is applied to the meter, the relays will always reflect the state of the input to the meter.
DEADBAND: 0-100%, User selectable.

ISOLATED 4-20 mA TRANSMITTER OUTPUT

CALIBRATION RANGE: The transmitter output can be calibrated so that a 4 mA output is produced for any number displayed on the meter. The 20 mA output may correspond to any number displayed on the meter that is at least 501 counts greater or smaller than the 4mA output display. (Ex. 4 mA = 0, 20 mA = 501) If the span between 4 and 20 mA is less than 501 counts, an error message will appear.
OUTPUT LOOP RESISTANCE: 1500 ohms max. using a 35V external power supply. 500 ohms max. using the built-in loop power supply. Built-in loop power supply available for either 4-20 mA output or signal input, but not both.
ACCURACY: ± 0.1% FS, ± .004 mA
ISOLATION: 500 VDC or peak AC, input-to-input or input/output-to-power line.
EXTERNAL LOOP POWER SUPPLY: 35 V max.

LINEARIZATION OPTION

- *11 POINT USER CALIBRATION*

  MINIMUM INPUT SPAN: 5 V range: 0.16 / (# of points-1) V; 10 V range: 0.32 / (# of points-1) V;4-20 mA range: 1.6 / (# of points-1) mA. (Ex. minimum span for a 11 point 4-20 mA calibration is .16 mA)
- *SQUARE ROOT EXTRACTION*

  ACCURACY: ± 0.1% F.S. ± 1 count from 10-100% of flow.
  LOW FLOW CUTOFF: 0-100% of full scale, user selectable.

CONNECTIONS: Removable screw terminal block (provided), accepts 24 to 12 AWG.

PRECISION DIGITAL

⚠ WARNING:
Hazardous voltages exist within enclosure. Calibration and service should be performed only by trained service personnel.

⚠ AVERTISSMENT:
Les pièces à l'intérieur du boîtier portent des tensions dangereuses. Seules des personnes qualifiées et bien entrainées devraient entreprondre l'ótalonnage et la maintenance.

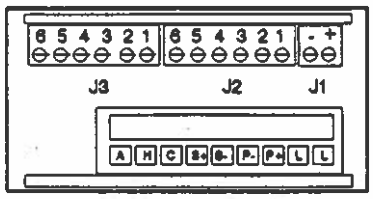
OPTION CARD INSTALLATION

PD690 options may be ordered installed at the factory. If an option is ordered as a separate item, refer to page seven of this manual for installation instructions.

OPTION CARD PIN OUTS

	Pin	Function:	
J1	1	Transmitter +	PD175
	2	Transmitter –	
J2	1	Relay #1 Common	PD174, PD176, PD178
	2	Relay #1 NC	
	3	Relay #1 NO	
	4	Relay #2 Common	
	5	Relay #2 NC	
	6	Relay #2 NO	
J3	1	Relay #3 Common	PD177, PD178
	2	Relay #3 NC	
	3	Relay #3 NO	
	4	Relay #4 Common	
	5	Relay #4 NC	
	6	Relay #4 NO	

Notes:
1. Alarm acknowledgement terminals (ACK and COM) are located on the meter main board.
2. In the alarm condition, the NC contact is connected to common.



RELAYS

A PD690 is available with 2 and 4 relays. The SP relays can be programmed for automatic or automatic + manual reset. The relays can also be programmed for 0-100% deadband.

Set & Reset Point Programming

Refer to the PD690 Instruction Manual to program the alarm (relay) Set and Reset points.

Automatic & Manual Reset Programming

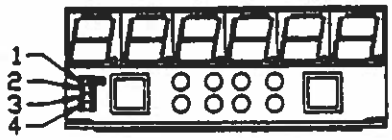
There are two ways to reset the relays:

1. Automatically when the signal passes through the Reset point.

2. Automatically + manually via the front panel ACK button, or a user supplied switch across terminals at the rear of the instrument. That is, a relay may be manually reset prior to the signal passing through the Reset point, or, if it is not, it will automatically reset when the signal passes through the Reset point.

A manual reset will reset all relays that are programmed for automatic + manual reset.

An array of jumpers located behind the front panel on the Display Board is used to program each relay for either automatic or automatic + manual reset. Refer to page 6 of this manual for front panel removal instructions. The top jumper is used for relay 1, the next for relay 2, etc. A relay will automatically reset if no jumper is installed. A relay will automatically reset, plus can be manually reset, if a jumper is installed over its respective pins.



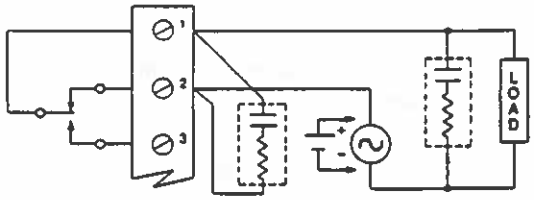
Jumpers to program relays for either automatic or automatic + manual reset. Relay 1 is programmed for automatic reset; Relays 2,3, & 4 are programmed for automatic + manual reset.

SWITCHING INDUCTIVE LOADS
(for PD174, PD176, PD177, PD178 Options)

Switching inductive loads, even quite small loads, can generate sufficient electrical noise to disrupt the operation of the PD690's relays. To minimize the effect of electrical noise, and also prolong the life of the relay contacts, the use of suppression is recommended.

This suppression can be obtained with RC networks assembled by the user or purchased as a complete assembly. Refer to the following circuits for RC network assembly and installation:

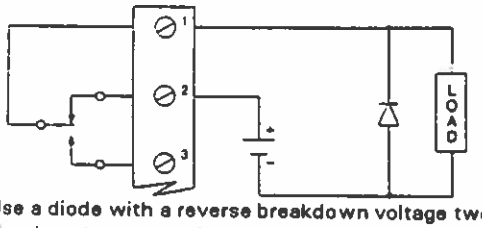
AC & DC LOADS:



Choose R and C as follows:
R: 0.5 to 1 ohm for each volt across the contacts
C: 0.5 to 1 microfarad for each 1 A through closed contacts

Notes:
1. Use capacitors rated for 240 VAC.
2. Snubbers may affect load release time of solenoid loads, check to confirm proper operation.
3. Install the RC network right at the PD690's relay screw terminals. A RC network may also be installed across the load. Experiment for best results.

LOW VOLTAGE DC LOADS:



Use a diode with a reverse breakdown voltage two to three times the circuit voltage and forward current at least as large as the load current.

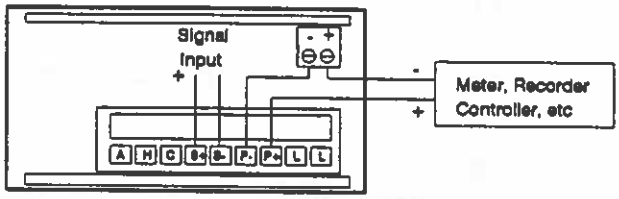
PRECISION DIGITAL SUPPLIED RC NETWORKS: Precision Digital can supply RC networks, (made by Okaya Electric), to assist customers in selecting the proper suppressor value for their application. Two suppressors of the value that satisfies most applications, can be supplied at no charge. Or, a kit (Precision Digital part number PDX-6908), containing 2 each of 8 different values of suppressor can be supplied for $35.00. When the suppressor value that best satisfies the application is determined, additional suppressor may be ordered from Okaya's distributor; Atlantic Components at 1-800-433-6600.

ISOLATED 4-20 mA OUTPUT OPTION

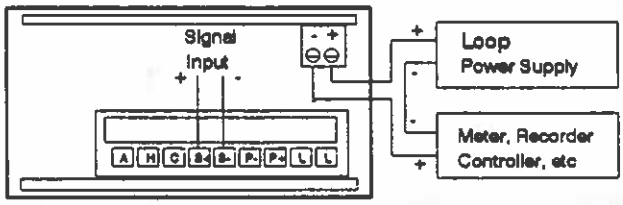
The PD690 can be equipped with an isolated 4-20 mA output signal option that can be programmed to produce a 4-20 mA output for virtually any input.

Connections

The following drawings illustrate the 4-20 mA output signal being powered from the PD690's internal 24 V power supply and by an external power supply.



4-20 mA output signal being powered by PD690's internal 24 V power supply.



4-20 mA output signal being powered from an external 24 V power supply.

Calibration

The isolated 4-20 mA output signal is calibrated using the front panel ENTER button and uses the same *S*ingle *B*utton *S*caling technique that is used to calibrate the signal input and the alarm Set and Reset points. A multimeter may be connected to the output terminals to verify calibration, but it is not required as part of the calibration process.

4 mA Output Calibration

1. Push ENTER. When *outPut* appears, push ENTER again.

2. A green LED labelled "4" illuminates indicating the flashing display is the value at which the meter will produce a 4 mA output.

3. The display will flash for 3 seconds.
If this is the desired display at which the meter will produce a 4mA output, push ENTER before the entire display stops flashing. The meter indicates that the 4 mA Output Calibration is now complete by illuminating the green "20" LED. Go to 20 mA Output Calibration listed below. (If ENTER is not pushed in time to accept the display, it is necessary to complete 4 mA Output Calibration.)

If this is not the desired display, (or if ENTER was not pushed in time to accept the display) wait for the first (right hand) digit to flash. It flashes for 3 seconds before it starts to scroll.

4. If the flashing digit is OK, push ENTER before it scrolls, next digit to the left flashes- go to step 6. If not OK, wait for first digit to scroll.

5. When first digit is OK, push ENTER, next digit to the left flashes for 3 seconds before it starts to scroll.

6. If flashing second digit is OK, push ENTER before it scrolls, go to step 8. If not OK, wait for digit to scroll.

7. When digit is OK, push ENTER. Third digit flashes for 3 seconds before it starts to scroll.

8. If flashing third digit is OK, push ENTER before it starts to scroll, go to step 10. If not OK, wait for digit to scroll.

9. When third digit is OK, push ENTER. Fourth digit flashes for 3 seconds before it starts to scroll.

10. If fourth flashing digit is OK, push ENTER before it starts to scroll and go to step 12 to set the left hand digit. If not OK, wait for fourth digit to scroll.

11. When fourth digit is OK, push ENTER. The left hand digit flashes for 3 seconds before it scrolls.

12. If the flashing left hand digit is OK, push ENTER before it scrolls and go to step 14 to complete 4 mA Output Calibration. If not OK wait for the digit to scroll.

13. When left hand digit is OK, push ENTER.

14. The entire display flashes for 3 seconds. Push ENTER if OK to complete 4 mA Output Calibration and proceed to 20 mA Output Calibration described below. If not OK, wait, the first digit flashes.
Repeat steps 4-14.

20 mA Output Calibration
(Note: The 20 mA output calibrates in the same fashion as 4 mA output so the 4 mA Calibration Instructions will be referenced for most of the 20 mA Calibration Instructions.)

1. When ENTER is pushed to complete the calibration for 4 mA output, the green LED labelled "20" illuminates indicating the flashing display is the value at which the meter will produce a 20 mA output.

2. Repeat steps 3-14 in 4 mA Output Calibration above.

3. Upon acceptance of the display corresponding to the 20 mA output, the meter exits the *outPut* routine and returns to displaying the input signal.

4. An *Error* message will be displayed if the 4-20 mA output span is smaller that 501 counts.

Programming Confirmation
The values that have been programmed to produce the 4 & 20 mA outputs can be quickly checked to make sure they are the desired values. To do this, enter the *outPut* routine by pushing ENTER and then pushing ENTER again when *outPut* appears.

The green "4" LED illuminates indicating the meter is displaying the value at which it will produce a 4 mA output. Confirm that this is the desired value. Push ENTER (within 3 seconds) before the entire display stops flashing and the green "20" LED illuminates indicating the meter is displaying the value at which it will produce a 20 mA output. Confirm that this is the desired value. Push ENTER (within 3 seconds) before the entire display stops flashing and the meter returns to displaying the input signal.

If the 4 or 20 mA output values were not as desired, refer to calibration instructions above to change them.

LINEARIZATION OPTION

The linearization option has two modes of operation: The 11 point user calibration (*L*) is for displaying non-linear signals and the square root extraction (*S*) is for displaying the flow rate from a differential pressure transmitter.

11 POINT USER CALIBRATION

The 11 point user calibration option is used to input up to 11 calibration points and corresponding displays to handle a variety of non-linear signals.

11 point user calibration does not require any tools or disassembly of the meter. The only equipment needed is a calibrated signal source.

The 11 point user calibration option is calibrated using the front panel ENTER button and uses the same *S*ingle *B*utton *S*caling technique that is used for 2 point calibration.

11 point user calibration is the same as 2 point calibration, except it has more points. The PD690 Instruction Manual provides detailed instructions for 2 point calibration, (under **2 Point Calibration** *(CALIb)*) on page 3.

To gain an understanding of *S*ingle *B*utton *S*caling, refer to the 5 basic calibration instructions that are listed under **2 Point Calibration** *(CALIb)* on page 3 of the PD690 Instruction Manual. Also refer to the **2 Point Calibration Flow Chart** on page 6 of the PD690 Instruction Manual.

Setup and Power & Signal Connections

Refer to the **SETUP** and the **Power & Signal Connections** sections on page 2 of the PD690 Instruction Manual for signal input selection and connections information.

Decimal Point *(dEC Pt)*

To program the decimal point or illuminate the extra "0", refer to the **Decimal Point** *(dEC Pt)* section on page 3 of the PD690 Instruction Manual.

11 Point User Calibration *(L or S)*

To program the PD690 for 11 point user calibration, push ENTER. When *L or S* appears, push ENTER again.

The meter will display *L or S* alternately. Press ENTER when *L* is flashing. After *L* is selected the meter will switch to indication mode and is ready to be calibrated.

Number of Calibration Points *(no. PtS)*

The user may input up to 11 calibration points and corresponding displays. To program the number of calibration points, push ENTER, when *no. PtS* appears, push ENTER again.

The meter displays a number from 2 to 11 that represents the number of calibration points. Push ENTER when the number equals the desired number of calibration points.

As soon as the number of points is programmed, the meter flashes *InPt 1*. Apply input signal and push ENTER. Complete Input 1 calibration by following steps 3 through 14 under **Input 1 Calibration** on pages 3 & 4 of the PD690 Instruction Manual.

When Input 1 has been calibrated, the meter will flash *InPt 2*, apply input 2 signal and calibrate the display in the same fashion as Input 1.

Calibrate the remaining inputs in the same fashion. When the last input has been calibrated, the meter will revert to displaying the process signal input.

Round Horizontal Tank Calibration Table

The following tables can be used to calibrate the PD690 for displaying volume in a round horizontal tank.

No. of Points: 10 Max. Error: 0.3% F.S.

Input:	mA:	Display: (% Volume)
1	4.0	0.00
2	4.8	1.80
3	6.0	7.20
4	7.2	14.20
5	9.2	28.10
6	14.8	71.80
7	16.8	85.80
8	18.0	92.80
9	19.2	98.10
10	20.0	100.00

No. of Points: 8 Max. Error: 0.5% F.S.

Input:	mA:	Display: (% Volume)
1	4.0	0.00
2	4.8	1.90
3	6.4	9.50
4	8.4	22.40
5	15.6	77.70
6	17.6	90.50
7	19.2	98.10
8	20.0	100.00

Programming Confirmation

The values that have been programmed for the 11 point user calibration can be quickly checked to make sure they are the desired values. To do this, apply the desired signal for each point and check the display.

SQUARE ROOT EXTRACTION

The square root extraction option takes the square root of a 4-20 mA or 1-5 V signal from a differential pressure transmitter and displays the flow rate in engineering units.

The square root extraction option is calibrated using the front panel ENTER button and uses the same *S*ingle *B*utton *S*caling technique that is used for 2 point calibration. Calibration involves setting only 3 points: the zero flow rate (usually 0), the high flow rate and the low flow cutoff point.

Square Root Extraction does not require any tools or disassembly of the meter. The only equipment needed is a calibrated signal source.

Setup and Power & Signal Connections

Refer to the **SETUP** and the **Power & Signal Connections** sections on page 2 of the PD690 Instruction Manual for signal input selection and connections information.

Decimal Point (*dEC Pt*)

To program the decimal point or illuminate the extra "0", refer to the **Decimal Point (*dEC Pt*)** section on page 3 of the PD690 Instruction Manual.

Square Root Extraction (*L or S*)

To program the PD690 for square root extraction, push ENTER. When *L or S* appears, push ENTER again.

The meter will display *L or S* alternately. Press ENTER when *S* is flashing. Once *S* is selected the meter will switch to indication mode and is ready to be calibrated.

Calibrate the meter by following steps 3 through 14 under Input 1 Calibration on pages 3 & 4 of the PD690 Instruction Manual.

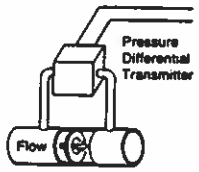
Ex. 4 mA input = 0 GPM and 20 mA input = 100,000 GPM

Low Flow Cutoff (*CutoFF*)

Low Flow Cutoff allows the PD690 to be programmed that the often unsteady output from a differential pressure transmitter at low flow rates always displays a zero on the PD690.

To program the PD690 for low flow cutoff, push ENTER. When *CutoFF* appears, push ENTER again. All digits flash for 3 seconds. If this is the desired low flow cut off value push ENTER before the entire display stops flashing. If this is not the desired display, follow steps 3 through 14 under Input 1 calibration on pages 3 & 4 of the PD690 Instruction Manual. After the point is programmed the meter will switch to indication mode.

Ex. If low flow cutoff is set at 1200, any flow of 1200 or less will be displayed as "0".



The PD690-X-12-Z can be used to display flow rate.

OPTION CARD INSTALLATION

PD690 options may be ordered completely installed at the factory. If an option card is ordered separately, refer to following instructions and the PD690 cover assembly drawing on this page for installation instructions.

Disconnect power prior to performing the following operations.

The PD690's snap-off cover is held in place by 6 latches that snap into notches on the snap-off cover. To remove the snap-off cover from the PD690, grasp it firmly on its top and bottom edges and pull it forward. The latch plate remains around the PD690's case.

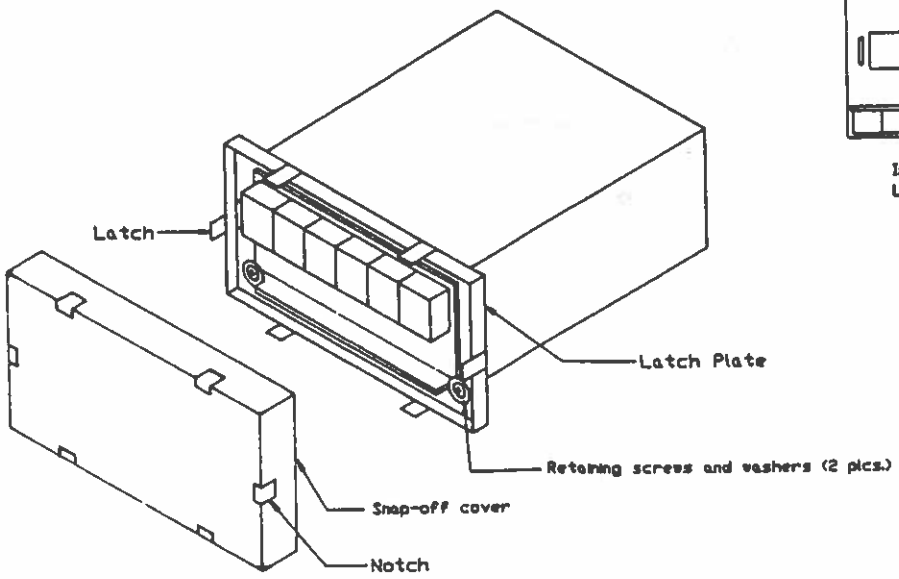
To remove the PD690 from its case, unscrew the two front panel retaining screws and remove the removable screw terminal block at the rear of the meter. Push the meter through its case by applying pressure to the PCB at the rear of the meter. Do not apply pressure to the vertical Display PCB.

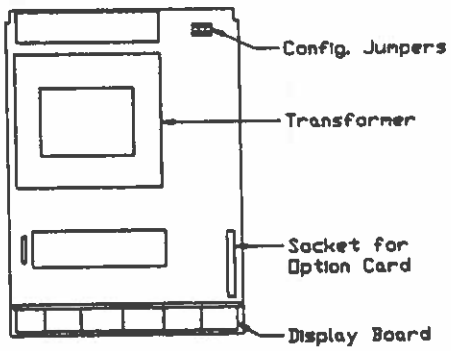
An option card is connected to the PD690 by the flexible cable which is permanently attached to the option card. Place the PD690 and the option card side by side, with the PD690 (with its display facing you) on the left, and with the option card (with its flexible cable next to the PD690) on the right. Plug the flexible cable from the option card into the socket on the PD690.

To avoid electric shock potential, re-install the completed PD690 assembly in its case prior to applying power. All programming and calibrating can be performed with the PD690 in its case.

To re-install the PD690 in its case, fold the option board over the PD690, grasp both boards so the PD690 is on the bottom and the two PCB's are separated by about an inch. Insert the two boards together into the case. Be sure both the top and bottom boards engage the rails which hold them in place. Do not press on the PD690 Display Board when seating the assembly in the case.

Install washers and retaining screws in 4 corners of meter and front cover.





Internal View of Meter for Locating Option Connector

PRODUCT REGISTRATION FORM

Name:_____ Title:_____
Company:_____
Address:_____
City:_____ State:_____ Zip:_____
Tel:_____ Fax:_____
Model Number: PD690-_____
Serial Number:_____
Date Installed:_____
Quantity:_____
Bought From:_____
Application:_____

_____

Comments:_____

_____

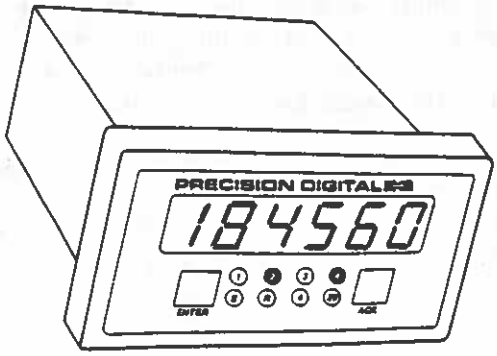
_____

__ Please send me a Precision Digital Catalog

Please fax this card to Precision Digital at 508-655-8990

D I G I T A L P A N E L M E T E R S

Model PD690 Instruction Manual



The PD690 is a high performance, industrial-grade digital process meter. It accepts all the standard process signals: 4-20 mA, 0-20 mA, 10-50 mA, 0-5 V, 1-5 V and 0-10 V and displays these signals in engineering units on a 4 1/2 digit display. The display also includes an extra zero which may be used to handle numbers up to 199,990.

*S*ingle *B*utton *S*caling allows calibration to be performed via a single front panel push-button. There are no complicated menu trees to navigate or button-pushing sequences to memorize.

An internal 24 V power supply is available to power the transmitter.

The NEMA 4 rated front panel makes the PD690 ideal for location in wet and dirty areas.

Options for the PD690 include 2 and 4 relays; 4-20 mA output; or 2 and 4 relays with 4-20 mA output. The PD690 is also available with a multi-point linearization option for applications such as displaying volume in a round horizontal tank or extracting the square root from a differential pressure transmitter.

ORDERING GUIDE

PDM P/N:	**PD690-X-Y-Z**
Power: 117 VAC (-3); 230 VAC (-4)	( )
Calibration: 2 Point (-N) Multi-point (-12)	( )
Options: None (-N)	( )
PD174 2 Relays (-14)	
PD175 Isolated 4-20 mA Output (-15)	
PD176 2 Relays + 4-20 mA Output (-16)	
PD177 4 Relays (-17)	
PD178 4 Relays + 4-20 mA Output (-18)	

Example: A PD690 powered from 117 VAC, with 2 point calibration and 2 relays would be PD690-3-N-14.

SPECIFICATIONS

INPUTS: Field selectable: 4-20 mA, 0-20 mA, 10-50 mA, 0-5 V, 1-5 V, 0-10 V

DISPLAY: Bright, large, 0.56" (14.2mm) high efficiency red LED. 4 1/2 digits + extra zero may be switched on to display +/-19,999(0). Leading zeros blanked.

CALIBRATION RANGE: 4 mA (1V) input may be set anywhere in range of the meter. 20 mA (5V) may be set anywhere above or below 4 mA input.

LOOP POWER: Isolated, up to 20 mA at 24 VDC regulated, noise less than 10 mV p-p. Max. loop resistance of 1200 ohms. Use to power either external transmitter or 4-20 mA output signal.

HOLD READING: Connect terminals HLD and COM.

ACCURACY: 0.05% of calibrated span, +/- 1 count.

LOCKOUT: Jumper 3 at rear of instrument restricts modification of calibration values.

INPUT IMPEDANCE: Voltage ranges, greater than 100 Kohms, current ranges, 100 ohms.

POWER: 117 VAC or 230 VAC +/- 10%, 50/60 Hz, 10 VA.

COMMON MODE REJECTION: 110 db.

NORMAL MODE REJECTION: 64 db. at 50-60 Hz

ENVIRONMENTAL:
Operating temperature range: 0 to +65 C
Storage temperature range: -40 to +85 C
Relative humidity: 0 to 90% non-condensing

ENCLOSURE: 1/8 DIN, ABS plastic, UL 94V-0.

FRONT PANEL: NEMA 4, panel gasket provided.

CONNECTIONS: Removable screw terminal block (provided), accepts 24 to 12 AWG.

ALARM POINTS: 4, any combination of high or low alarms

ALARM STATUS INDICATION: Front panel LED

ALARM DEADBAND: 0-100% of full scale, user selectable.

WARRANTY: 1 year parts & labor

⚠ **WARNING:**
Hazardous voltages exist within enclosure. Calibration and service should be performed only by trained service personnel.

⚠ **AVERTISSMENT:**
Les pièces à l'intérieur du boîtier portent des tensions dangereuses. Seules des personnes qualifiées et bien entrainées devraient entreprondre l'ótalonnage et la maintenance.

PRECISION DIGITAL CORPORATION
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PRECISION DIGITAL

DESCRIPTION

All PD690s, regardless of configuration, have the same front panel. The front panel consists of a single button for programming and calibrating labelled ENTER and another button for resetting the relays labelled ACK.

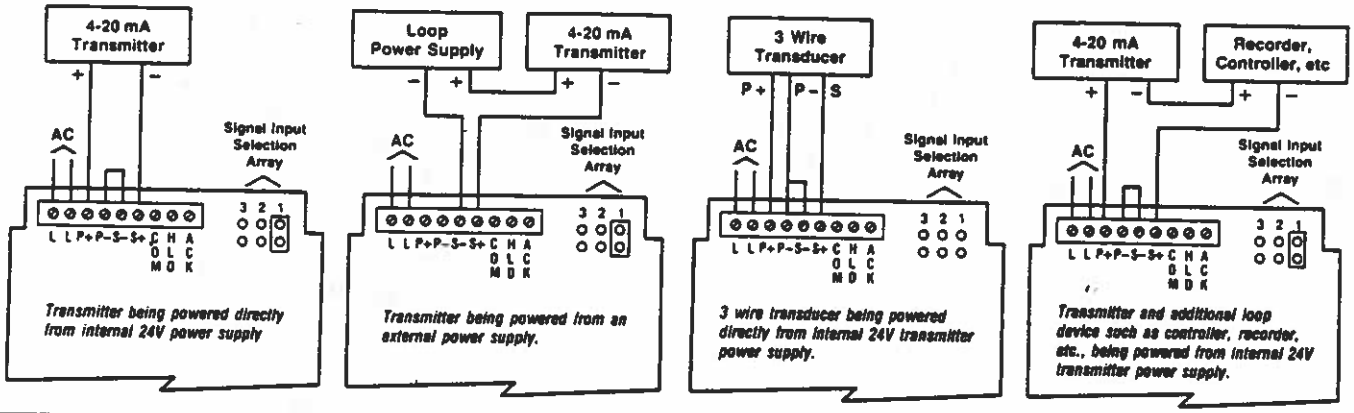
In addition, the PD690 front panel includes LEDs that illuminate to assist in 4-20 mA output and alarm programming. LED's are also provided to indicate alarm condition.

SETUP

Program the Signal Input Selection Array for desired input per chart below. This jumper array is located at the rear of the instrument, next to the screw terminal block. Remove jumper 3 (if installed) to disable Lockout feature.

Input Signal:	Jumper 1:	Jumper 2:
1-5, 0-5V	OFF	OFF
0-10 V	OFF	ON
0-20, 4-20, 10-50 mA	ON	OFF

Power & Signal Connections

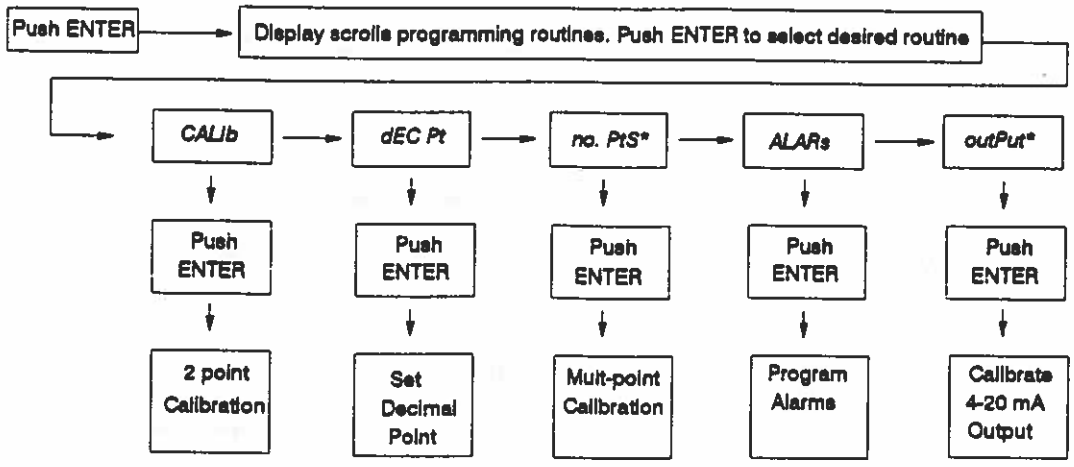


PROGRAMMING

The PD690's *S*ingle *B*utton *S*caling allows it to be programmed using only the ENTER button. The general procedure is to push the ENTER button to accept a flashing display or to wait for the display to scroll and push ENTER when the desired display appears.

For instance the first time the ENTER button is pushed, the meter scrolls through the standard programming routine titles: *CALib, dEC Pt, ALARs*. It will also scroll the optional programming routine titles: *outPut* and *no. PtS* if the meter contains an isolated 4-20 mA Output Option or a Multi-point Linearization Option. To enter a programming routine, push ENTER when the meter displays the desired programming routine title.

The following flow chart overviews the PD690 programming routines.



* Only appears if this option is installed, see Options manual for details

CALIBRATION

'ibration is performed from the front panel using the TER button. It does not require any tools or disassembly of the meter. The only equipment needed is a calibrated signal source.

For best results, allow the meter to warm up for at least 30 minutes.

The calibration input signals may be any value within the range of the meter, except Input 2 must be greater than Input 1. (However, the display for Input 2 does not have to be greater than the desired display for Input 1.)

The following calibration instructions also illustrate an example (Ex.) calibration of 4 mA input = 0000.0 and 20 mA input = 1475.0.

Decimal Point (*dEC Pt*)

To program the decimal point or light up the extra "0", push ENTER. The meter displays *CALIb*, then *dEC Pt*. Push ENTER when dEC Pt appears. The meter then reads 199990 with the decimal point changing locations and the extra "0" illuminating. Push ENTER when the decimal point is in the desired position; or if the extra "0" is desired; when the extra "0" is displayed.

Ex. Push ENTER. When *dEC Pt* appears, push ENTER. When meter reads 1999.9, push ENTER.

ıbration (*CALIb*)

The following *S*ingle *B*utton *S*caling technique is also used to program the Alarm Set and Reset points, the 4 mA and 20 mA output values, and the multi-point linearization.

There are 5 basic calibration instructions:

1. If the flashing **entire display** is OK, push ENTER before it stops flashing to accept it.

2. If the flashing **entire display** is not OK, (or if ENTER was not pushed in time to accept it), wait for Least Significant Digit (LSD) to flash.

3. If a flashing **digit** is OK push ENTER before it starts to scroll to accept it.

4. If a flashing **digit** is not OK, (or if ENTER was not pushed in time to accept it), wait for the digit to scroll, and push ENTER when OK.

5. Digits will scroll until ENTER is pushed. When a digit is accepted by pushing ENTER, the next digit to the left flashes.

.libration flow chart appears on the back page.

Input 1 Calibration

1. Push ENTER. When *CALIb* appears, push ENTER again.

Ex. Push ENTER. When *CALIb* appears, push ENTER, again.

2. The meter flashes *InPt 1*. Apply Input 1 signal (e.g. 4 mA, 0 V, 1V, etc) and push ENTER.

Ex. Apply 4 mA and push ENTER.

3. All digits flash for 3 seconds.

Ex. Flashing display = some random number, say 0000.5

If this is the desired display for Input 1, push ENTER before entire display stops flashing. This would complete Input 1 Calibration, (indicated by the meter flashing *InPt 2*), so go to Input 2 Calibration described below. (If ENTER is not pushed in time to accept the display, it is necessary to complete Input 1 Calibration.)

Ex. Flashing display of 0000.5 does not equal our desired 4 mA display of 0000.0, therefore we don't push ENTER.

If this is not the desired display, (or if ENTER was not pushed in time to accept the display) wait for the first (right hand) digit to flash. It flashes for 3 seconds before it starts to scroll.

Ex. Flashing display of 0000.5 does not equal our desired 4 mA display of 0000.0, therefore we wait for first digit to flash.

4. If the flashing digit is OK, push ENTER before it starts to scroll, next digit to the left flashes- go to step 6. If not OK, wait for first digit to scroll.

Ex. Flashing 5 is not what we want, 0000.*0*, so we wait for 5 to change to 6, 7...

5. When first digit is OK, push ENTER, next digit to the left flashes for 3 seconds.

Ex. Flashing 5 continues to change to 8, 9, and when it flashes 0, we push ENTER. If we don't push ENTER in time and digit continues to change to 1,2,3...., wait for 0 to come around again and push ENTER when it reads 0. Once ENTER is pushed, the second digit begins to flash (and will flash for 3 seconds before it begins to scroll.)

6. If flashing second digit is OK, push ENTER before it scrolls, go to step 8. If not OK, wait for digit to scroll.

Ex. Flashing 0 is what we want for 000*0*.0, so we push ENTER before it scrolls and go to step 8.

7. When digit is OK, push ENTER. Third digit flashes.

Ex. We skipped this step because flashing 0 was OK.

8. If flashing third digit is OK, push ENTER before it scrolls, go to step 10. If not OK, wait for digit to scroll.

Ex. Flashing 0 is what we want for 0000.0, so we push ENTER before it scrolls.

9. When third digit is OK, push ENTER. Fourth digit flashes.

Ex. We skip this step because flashing 0 was OK.

10. If fourth flashing digit is OK, push ENTER before it scrolls and go to step 12 to set the left hand digit. If not OK, wait for fourth digit to scroll.

Ex. Flashing 0 is what we want for 0000.0, so we push ENTER before it scrolls and we're ready to set the left hand digit.

11. When fourth digit is OK, push ENTER. The left hand digit flashes.

Ex. We skip this step because flashing 0 was OK.

12. The left hand digit can read zero, a negative sign, a -1 or a 1.

If the flashing left hand digit is OK, push ENTER before it scrolls and go to step 14 to complete Input 1 Calibration. If not OK wait for the digit to scroll.

Ex. Flashing 0 is what we want for 0000.0, so we push ENTER before it scrolls and go to step 14 to complete Input 1 Calibration.

13. When left hand digit is OK, push ENTER.

Ex. We skip this step because flashing digit was OK.

14. The entire display flashes for 3 seconds. Push ENTER if OK to complete Input 1 Calibration and proceed to Input 2 Calibration described below. If not OK, wait, the first digit flashes. Repeat steps 4-14.

Ex. If we have done everything right, the entire display flashes 0000.0. If it does, push ENTER to complete Input 1 Calibration.

If an error was made so that the entire display does not flash 0000.0, wait for first digit to flash and repeat steps 4-14.

Input 2 Calibration

(Note: Input 2 calibrates in the same fashion as Input 1 so we will use the example for most of the instructions)

1. When ENTER is pushed completing the calibration for InPt 1, the title *InPt 2* begins to flash. Apply Input 2 signal (e.g. 20 mA, 5V or 10V) and push ENTER.

Ex. Apply 20 mA and push ENTER.

2. Repeat steps 3-14 above. The following examp illustrates these steps for Input 2.

Input 2 Calibration Example:
1. Flashing display = some random number, say 1000.0.

2. Flashing display of 1000.0 does not equal our desired 20 mA display of 1475.0, therefore wait for first digit to flash.

3. Flashing 0 is what we want for 1475.*0*, so we push ENTER, the second digit flashes.

4. Flashing 0 is not what we want for the second digit of 1475.0, so we wait for 0 to change to 1,2,3...

5. When flashing digit = 5, push ENTER, third digit flashes.

6. Flashing 0 is not what we want for the third digit of 1475.0, so we wait for 0 to change to 1,2,3...

7. When flashing digit = 7, push ENTER, fourth digit flashes.

8. Flashing 0 is not what we want for the fourth digit of 1475.0, so we wait for 0 to change to 1,2,3...

9. When flashing digit = 4, push ENTER, the left hand digit flashes.

10. Flashing 1 is what we want for 1475.0, so we push ENTER before it scrolls and go to step 11 to complete the calibration process.

11. If we have done everything right, the entire display flashes 1475.0 If it does, push ENTER before it stops flashing to complete t calibration process. The meter exits the calibration routine and displa 1475.0 +-.8. If ENTER is not pushed in time, first digit flashes. Push ENTER repeatedly to skip through all the digits and push ENTER when entire display flashes.

If flashing display does not equal 1475.0, repeat steps 1 - 11.

Programming Confirmation

The calibration programming can be checked by entering the *CALib* routine, applying Input 1, say 4 mA, pushing ENTER, and pushing ENTER again (within 3 seconds) before the entire display stops flashing. Apply Input 2, say 20 mA, push ENTER, and push ENTER again (within 3 seconds) before the entire display stops flashing.

Calibration Error

A meter display of *Error* at the completion of the calibration process indicates that the calibration process was not successful. The meter should be recalibrated.

The *Error* message will appear if Input 1 signal and Input 2 signal are too close together*:

Input Range:	Minimum Difference Between Input 1 & Input 2:
5V	0.16 V
10V	0.32 V
4-20 mA	1.60 mA

*A common *Error* occurs when Input 1 signal is inadvertently also applied for Input 2 calibration.

4 ALARM POINTS

The PD690 is equipped with 4 alarm points as a standard feature. Each alarm may be programmed for either a high or low alarm and for 0-100% deadband. In addition, front panel LEDs indicate alarm status.

Options for 2 and 4 relays are available.

Alarm Programming

There are only two values to program for each alarm point: The Set point and the Reset point. The values chosen for these points determine if an alarm is a High or Low Alarm and the deadband.

The Alarm Set and Reset points are programmed using the same *S*ingle *B*utton *S*caling technique used to calibrate the signal input to the meter.

To program a High Alarm, program the Set point above the Reset point. To program a Low Alarm, program the Set point below the Reset point.

To program the alarm deadband, set the Reset point above or below the Set point by an amount equal to the desired deadband value.

Example: Alarm 2 is a High alarm that trips at 1500 and has a deadband of 100. Alarm 2 Set point is set at 1500 and its Reset point at 1400.

Alarm Set & Reset Point Programming: *(ALARs)*

Alarm Set & Reset point programming is performed in the *ALARs* routine.

1. To enter the *ALARs* routine, push ENTER and when ALARs appears, push ENTER again. This starts a scan of the 4 alarm Set & Reset points.

The scan sequence begins with a flashing display of Alarm #1 Set point. The "1" LED and "S" LED are illuminated to indicate the meter is flashing Alarm #1 Set point value.

2. All digits flash for 3 seconds.

If this is the desired display for this alarm point, push ENTER. Pushing ENTER completes this alarm point programming. Proceed to step 8 for next alarm point programming.

If this is not the desired display, wait for the first digit to flash. It will flash for 3 seconds before it starts to scroll.

3. If the first flashing digit is OK, push ENTER before it starts to scroll to accept it, the second digit flashes- go to step 6. If not OK, wait for first digit to scroll.

4. When the first digit is OK, push ENTER and the second digit flashes for 3 seconds before it starts to scroll.

5. If the second flashing digit is OK, push ENTER before it scrolls. If not OK, wait for digit to scroll.

6. When second digit is OK, push ENTER. Program remaining digits in same fashion.

7. When the left most digit is OK, push ENTER. The entire display flashes for 3 seconds. Push ENTER if OK to complete alarm point programming and proceed to step 8. If not OK, wait, first digit flashes. Repeat steps 3-7.

8. When an alarm Set or Reset point has been programmed the scan moves to the next alarm Set or Reset point. To program the remaining alarm Set & Reset points, repeat steps 2-8.

Determine which alarm Set or Reset point is being programmed by noting which LEDs are illuminated. For instance, if the "3" LED and the "R" LED are illuminated, the meter is displaying Alarm #3 Reset point. When alarm programming is complete the meter will display the process input signal and the front panel LEDs will indicate alarm status.

Programming Confirmation

To verify that the alarm Set and Reset points have been programmed as desired, push ENTER, and push ENTER again when *ALARs* appears. Before the display stops flashing #1 Set point value, push ENTER again to advance the display to #1 Reset point. Continue skipping through the remaining alarm Set and Reset points. To alter an alarm point value, wait for the first digit to flash and follow steps 3-8 above.

Alarm Operation

When the meter detects an alarm, a front panel LED illuminates to indicate which alarm point has been tripped. This LED will stay illuminated until the meter display passes through the Reset point.

Alarm Relays

If the meter has an optional relay card installed, refer to the PD690 Options Instruction Manual for details.

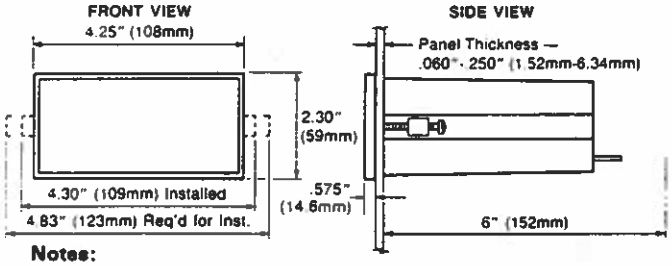
Alarm Acknowledgement

The ACK button on the front panel resets the optional relays only and has no effect on the alarm status LEDs.

LOCKOUT

Install jumper 3 at rear of instrument to restrict modification of calibration values. When ENTER is pushed with lockout jumper in place, only *ALARs* and *outPut* routines are displayed. These routines may be entered to view their settings, but the settings may not be altered.

MOUNTING

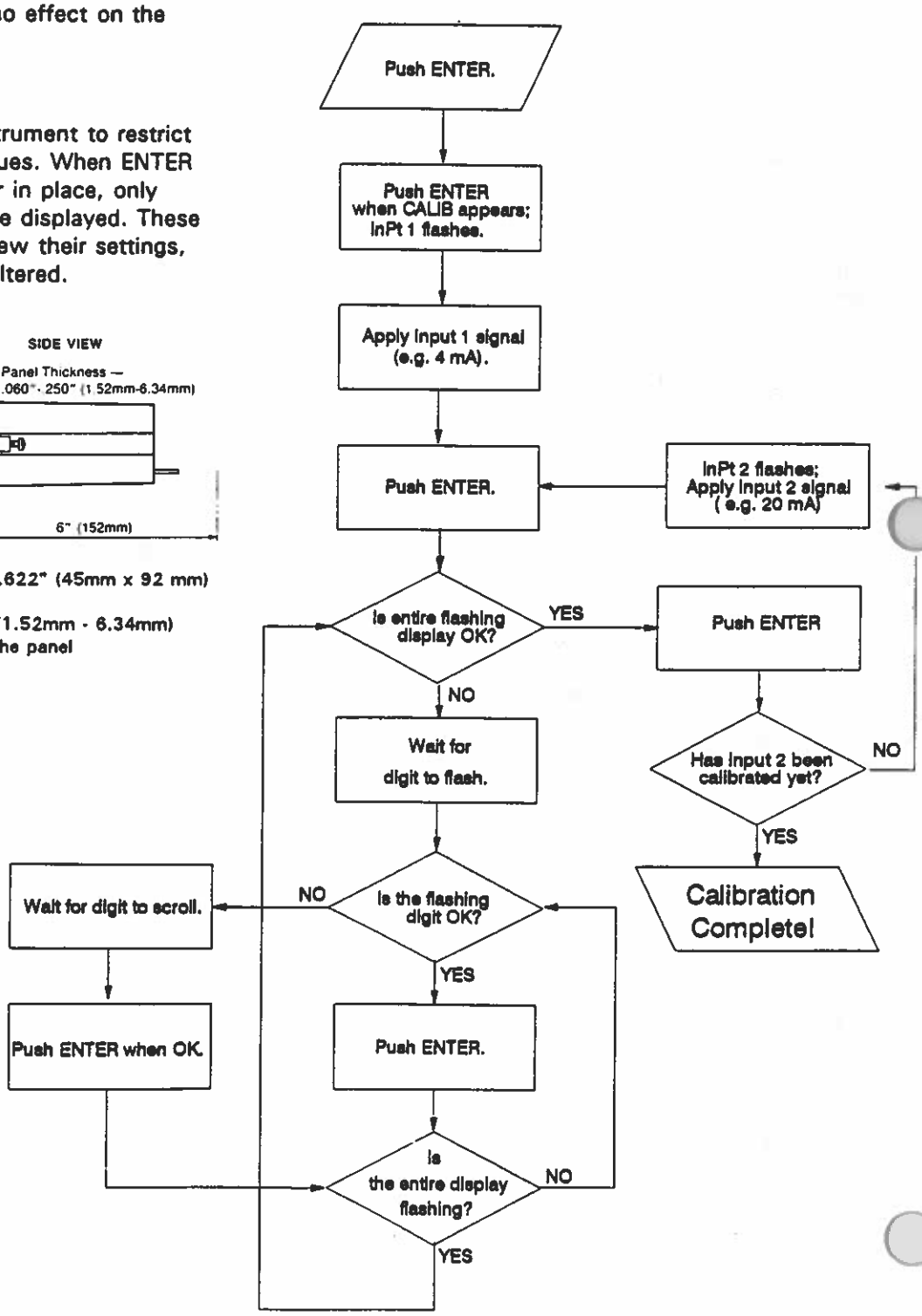


Notes:

1. Panel cutout required: 1.772" X 3.622" (45mm x 92 mm) 1/8 DIN
2. Panel thickness: 0.060" - 0.250" (1.52mm - 6.34mm)
3. Allow 6 inches (152 mm) behind the panel
4. Weight 16 oz, (454 g)

2 POINT CALIBRATION FLOW CHART

The following flow chart illustrates a 2 point calibration using *S*ingle *B*utton *S*caling. The same general procedure is used for multi-point calibrations, alarm Set and Reset point programming and 4-20 mA output programming.

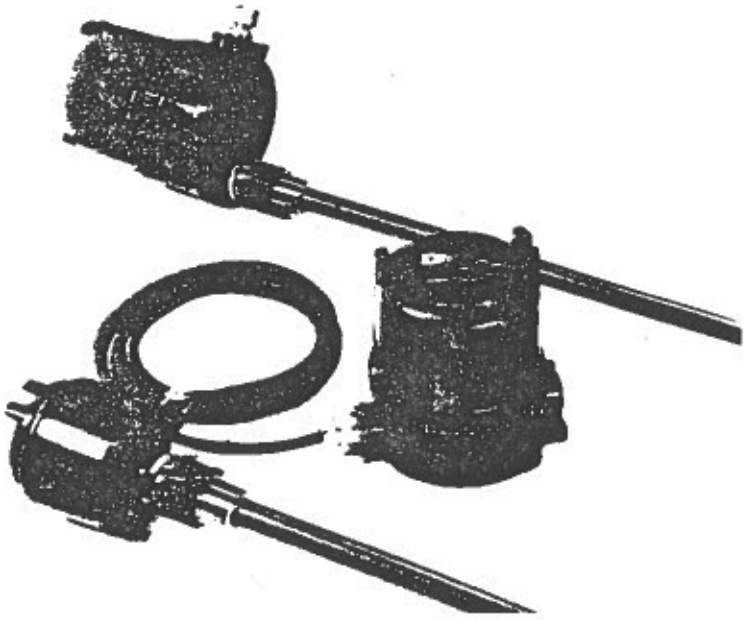


EDO# 5-94-244
408-8200-LM

Installation and Operating Instructions

for

Drexelbrook Series 508-45, -46, -47, -49 Universal II Level Transmitters Using 408-8200 Series Cote-Shield™ Electronics



For factory service, call toll free
1-800-527-6297

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SECTION 1- INTRODUCTION

The instructions in this manual are for the Drexelbrook 508-4X-XX Series Universal II system for level measurement in liquids, slurries, interfaces and granulars.

1.1 System Description

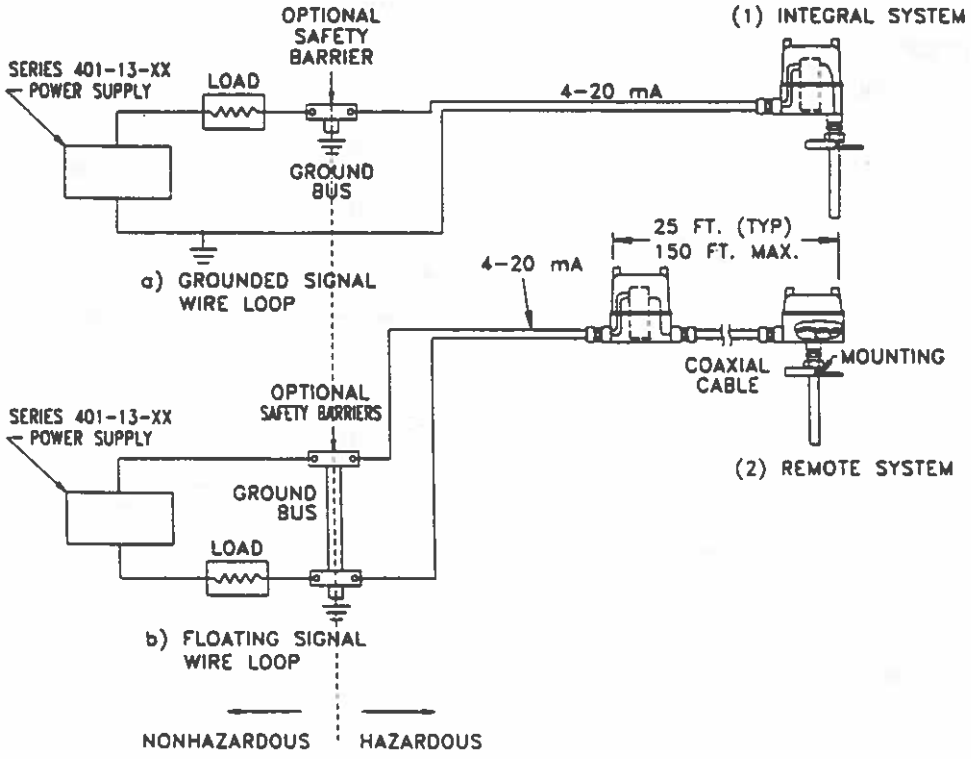
Each Drexelbrook 508-4X-X Universal II system Consists of a 408-8200 Series two-wire, 4-20 mA electronic unit and a 700 series sensing element (probe). Most 508-4X-XX Universal II systems are available in either integral or remote applications. A 380 series connecting cable is also supplied for remote systems.

The system model numbers indicate the application where they most often will be used:

508-45-X: For conducting liquids
508-46-X: For liquid/liquid interfaces
508-47-X: For insulating liquids
508-49-X: For granular solids

The final digits in the system model number refer to the type of 700 Series sensing element used.

The 508-4X-X is an admittance-to-current transducer. A change in level produces a change in admittance which results in a change in current. It is termed a two-wire transmitter because the same two wires used to power the unit also indicate the change in level (4-20mA). See Figure 1-1.



1.2 Models Available

1.2.1 Electronic Chassis

The following is a partial list of the various 408-82X2 Series chassis models available:

408-8202-1 — Basic electronic unit intended for use with insulating materials, interfaces, and semi-conducting granulars.

408-8232-1 — Basic electronic unit (408-8200) internally connected for use with conductive materials and certain insulating granulars.

408-82X2-1 — Time delay option included.

1.2.2 Housings

The 408-8200 Series electronic units are available in a NEMA 4 or explosionproof housing. A "1" in the last position of the electronic unit number indicates chassis only, no housing. Example, 408-82XX-X1 means chassis only. The standard housing meets the following NEMA classifications:

NEMA	
1	General Purpose
2	Drip Tight
3	Weather Resistant
4	Waterproof
4X	Waterproof/Corrosion Resistant
7	Explosionproof
9	Dust/Ignitionproof
12	Industrial use: oil and dust-tight

1.2.3 Sensing Elements

The following sensing elements are most often recommended with a 508-4X-XXX system according to the application require ments. See Section 1.3.3 for detailed specifications. This listing does not include all of the sensing elements available with the 508-4X-XX series system. For identification, the last digits of the sensing element model number are stamped into the mounting gland. If you have additional questions about sensing elements, contact the factory or your local representative.

700-1-22 — Rigid sensing element for waterlike conducting liquids.
700-1-24 — Concentric shield sensing element for waterlike insulating liquids.
700-1-34 — Caged sensing element for thick, insulating liquids.
700-2-24 — Rigid sensing element for low viscosity conducting liquids.
700-2-27 — Rigid sensing element for interface measurement which include ketones and esters.
700-2-37 — Rigid sensing element with a lower resistivity limit for interface measurements and thick conducting liquids.
700-2-57 — Heavy-duty, rigid sensing element for most conducting liquid and interface measurements.
700-5-18 — Flexible sensing element for agitated conducting liquids and for granulars.
700-5-19 — Heavy-duty, flexible sensing element for highly abrasive mineral granulars.
700-5-54 — Flexible sensing element for longer insertion lengths in waterlike conducting liquids.
700-202-23 — Rigid 3-terminal sensing element for short range spans in insulating liquids and granulars.
700-205-78 — Flexible sensing element with slack adjuster for insulating liquids and granulars.

1.2.4 Connecting Cables

When necessary to avoid excessive temperatures and vibration, the electronic unit and sensing element can be connected by a three-terminal coaxial cable. Drexelbrook cables are available in:

General Purpose: 380-XXX-12
High Temperature: 380-XXX-11
Composite: 380-XXX-18 (first 10 feet high temperature)

The XXX in the model number indicates the length of the cable in feet. 25 feet is standard (e.g. 380-025-12), but longer and shorter lengths are available. Cable can also be purchased in bulk lengths with termination kits. Consult factory for maximum recommended lengths per specific application.

1.3 Technical Specifications

1.3.1 Electronic Unit (typical)

A. Power requirement: 11.5 to 50 Vdc (For intrinsic safety, see "N" below.)

B. Input range: 408-8202: 3.75 to 40,000pF; 408-8232: 6 to 40.000pF with 5 ft. of cable.

C. Output range: 4-20 mA

D. Linearity: ±0.25%.

E. Load resistance:
$\frac{Vs-11.5^*}{.02}$ (i.e. max 625 @ 24Vdc).

*Where Vs = power supply voltage.

F. Temperature effect: ±0.25% of full scale per 30°F or ±0.1 pF whichever is larger.

G. Supply voltage effect: 0.2% max. from 11.5 to 50 VDC.

H. Effect of load resistance: 0.2% or less for full resistance range at 24 VDC supply.

I. Response to Step Change: 0.5-30 seconds standard (to 90% of final value)

J. Fail-Safe: Field adjustable. Low-Level Fail-Safe (LLFS) std. Also called direct acting because current increases as the level increases. High-Level Fail-Safe (HLFS). Also called reverse acting because current decreases as level increases.

Note: THERE ARE NO DEVICES THAT ARE ABSOLUTELY "fail-safe". "Fail-safe" means that in the event of the most probable failures, the instruments will fail safely. "Most probable failures" means such things as loss of power and most transistor and component failures. If your application needs absolute fail-safe, a backup instrument should be installed.

K. Ambient temperature: -40° to +150°F (-40° to 65°C) at 24 Vdc.

L. Calibration Adjustments: Step Zero, Fine Zero, Step Span, Fine Span, Time Delay.

M. Lowest permitted resistance (bare sensing element to ground) causing 5% error in each model:
600Ω - 8202
100KΩ - 8232

N. Intrinsic Safety: Sensing element and cable: Intrinsically safe for Class I Groups A, B, C and D; Class II Groups E, F and G (Div. 1 and 2).

Electronics and signal wires: Intrinsically safe for Class I Groups C and D, Class II Groups E, F and G (Div. 1) when powered by an intrinsically safe power supply. Non-incendive for Class I Groups A, B, C and D; Class II Groups E, F and G (Div. 2).

O. Cable Length: 150 feet maximum.

P. Independence of zero and span: ±1% maximum.

Q. RFI Protection: Inherent with unit against standard walkie-talkie interference; 5 ft. standard distance with proper installation.

1.3.2 Three-Terminal Cable

A. General Purpose:
380-XXX-12: .51" OD at largest point, 160°F temperature limit.

B. Composite Cable (first 10 feet high temperature):
380-XXX-18: .62" OD at largest point, 450°F temperature limit for first 10 ft. 160°F temp limit for remainder.

C. High Temp. Cable 380-XXX-11: .51" OD at largest point. 450°F temperature limit.

1.3.3 Sensing Elements

Mod. #	Std. Mat. of Construction	OD & Mtg.	Temp. & Press. Limits	Max Rec. Insertion Length	Sensing Element Type
700-1-22	TFE covered rod	Rod 3/8" OD 3/4" NPT	100°F @ 1000 psi 300°F @ 500 psi	20 ft.	2-term. rigid
700-1-24	TFE covered rod w/CS concentric shield	Concentric shield 1.66" OD 1 1/2" NPT	100°F @ 1000 psi 300°F @ 500 psi	20 ft.	2-term. rigid
700-1-34	TFE covered rod w/CS cage	Cage 4.026" OD 4" 150# flange	100°F @ 1000 psi 300°F @ 500 psi	19 ft.	2-term. rigid
700-2-24	TFE covered rod	Rod 3/4" OD 3/4" NPT	100°F @ 1000 psi 450°F @ 500 psi	14 ft.	2-term. rigid
700-2-27	TFE covered rod	Rod .54" OD 3/4" NPT	100°F @ 1000 psi 300°F @ 500 psi	12 ft.	2-term. rigid
700-2-37	*"X" covered rod	Rod .54" OD 3/4" NPT	100°F @ 1000 psi 250°F @ 500 psi	13 ft.	2-term. rigid
700-2-57	*"X" covered rod	Rod .84" OD 1" NPT	100°F @ 1000 psi 250°F @ 500 psi	20 ft.	2-term. rigid
700-5-18	*"X" covered cable	Cable 5/16" OD 3/4" NPT	100°F @ 1000 psi 250°F @ 500 psi	200 ft.	2-term. flexible
700-5-19	Urethane covered cable	Cable 3/4" OD 2" NPT	150°F @ 5 psi	200 ft.	2-term. flexible
700-5-54	PFA covered cable	Cable .093" OD 3/4" NPT	100°F @ 1000 psi 300°F @ 500 psi	400 ft.	2-term. flexible
700-202-23	Bare 316 SS rod	Rod 1/2" OD 1 1/2" NPT	100°F @ 1000 psi 450°F @ 200 psi	10 ft.	3-term. rigid
700-205-78	*"X" covered cable	Cable 5/16" OD 1" NPT	250°F @ 5 psi	200 ft.	3-term. flexible

*"X" is a fluorocarbon-type insulation.

SECTION 2-THEORY OF OPERATION

2.1 The Electronic Unit

The electronic unit operates on the bridge principle with an internal high frequency sinewave oscillator providing a stable measurement signal source. The instrument measures the capacitance or the admittance of the sensing element (probe) in the process. For the direct acting mode, the output of the instrument increases with increasing level (or increasing capacitance/admittance).

Figure 2-1 shows a block diagram of a Universal II level transmitter with the operator controls for zero level, high level (span) and time delay. The units are shipped in direct acting mode (LLFS) and either 8202 (insulating materials) or 8232 (conductive materials) mode.

The 408-8200 series has improved linearity and improved Cote-Shield performance. It also has built-in RFI protection on the 2-wire input/output wiring, built-in adjustable time delay and probe spark protection. In addition, the unit is compact enough to be mounted integrally with the probe and its housing thereby eliminating the need for the coaxial cable. Two test points are provided for the insertion of a standard milliammeter for measuring the loop current without breaking the current loop circuit.

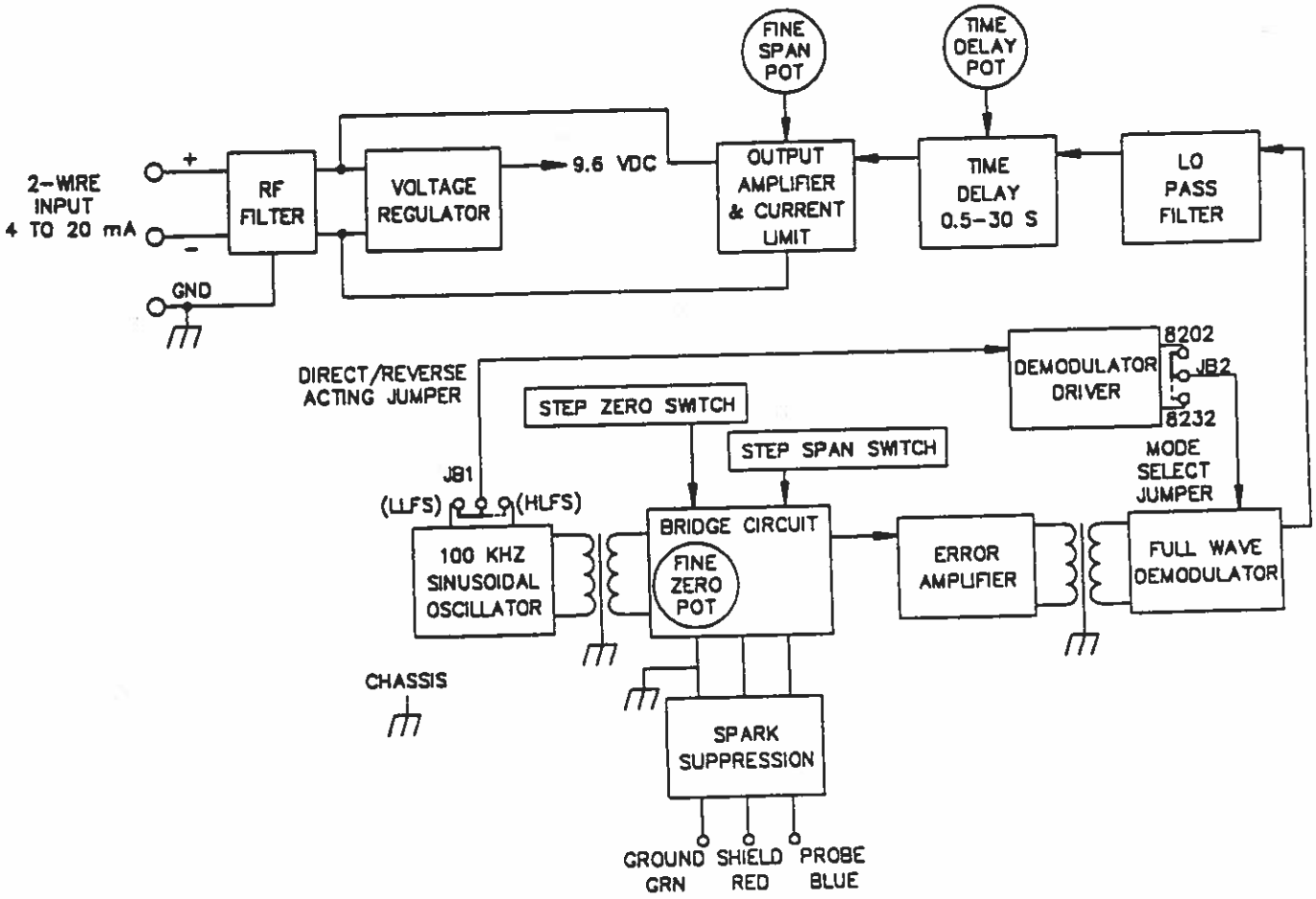


Figure 2-1
Block Diagram

Figure 2-2 shows a vessel filled with a highly conductive material. Since the material is conductive, the ground is effectively at the outside surface of the probe insulation in the bulk liquid, and the electronic unit sees only the capacitance of the sensing element. In this case, either a capacitance or a Cote-Shield (admittance) transmitter can adequately measure the level.

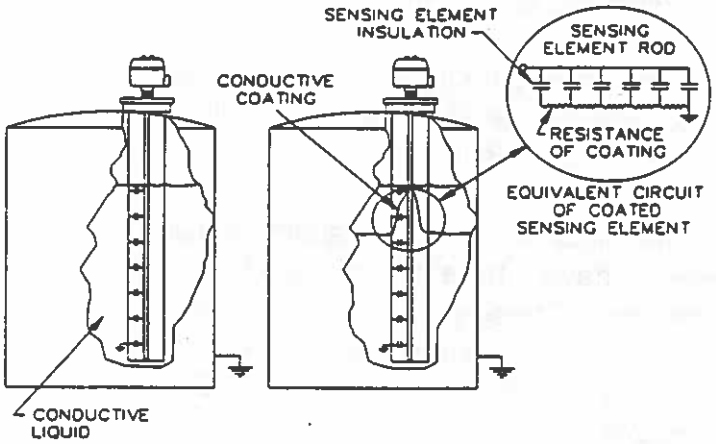


Figure 2-2
Conductive Coating on an Insulated Sensing Element

As the vessel is drained, the picture changes. What was before a pure capacitance circuit now contains a resistive element, because the resistance in the coating is much higher than in the bulk liquid. This combined resistance and capacitance signal is admittance.

In a typical capacitance unit, when the sensing element circuitry contains a resistive component, energy is consumed. The resistance of the coating draws down the oscillator voltage. This results in output error. To prevent this problem, the oscillator circuitry is designed so that the loss in power does not affect the oscillator voltage. With a capacitance instrument, the output would indicate that the level was still near the top of the coating, because there would still be the same amount of sensing element connected to ground. See Figure 2-2.

The coated portion of the sensing element models an electrical transmission line made up of an infinite number of tiny capacitive and resistive elements. Mathematically, it can be shown that if the coating is long enough, the resistive and capacitive parts of the coating have equal impedances. To benefit from this information, a DEMODULATOR circuit is used. This is the circuit that makes the major difference between a CAPACITANCE transmitter and an ADMITTANCE transmitter.

This circuit permits separate measurement of resistance and capacitance. The total capacitance is measured by adding the capacitance of the level plus the capacitance of the coating and subtracting an amount equal to the coating resistance. Since the resistive and capacitive current in the coating are equal, only the capacitance due to the actual level is measured, and the instrument, in effect, has "ignored" the coating. See Figure 2-2A.

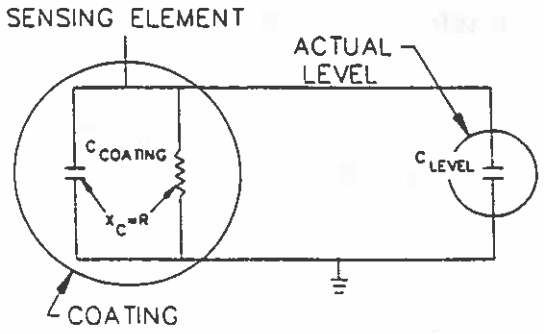


Figure 2-2A
Schematic of a Conductive Coating

The coating must be electrically "long" for this measurement to work perfectly. How long will depend on the thickness of the coating, the capacitance of the sensing element, the sensing element diameter, and the frequency at which the measurement is made. Generally, a coating of several inches to one foot is long enough not to produce an error. Shorter coatings have some error, but only a fraction of the length of the coating. For any one set of parameters, the coating error is in inches, not percent. A set of conditions that produces a coating error of one inch will always pro duce an error of one inch, regardless of the sensing element length or calibrated span. The bridge circuit allows spans as high as 40,000 pF. This span increase permits measurements in larger vessels and makes it possible to use sensing element with higher capacitance in order to improve the instrument's ability to reject the effects of coatings. A great advantage with this unit is that, because of the two-wire transmission, it can be made intrinsically safe. This often removes conduit and explosionproof requirements, and eliminates safety hazards to the instrument mechanic.

All of the above circuitry is fed from a conventional two-wire 24 Vdc. 4-20 mA power source.

2.2 Sensing Elements

The necessary change of input capacitance/ admittance is provided by a sensing element or "probe", which is mounted in or near the material being measured.

Sensing elements are available in many forms, depending chiefly on the application factors of temperature, pressure, insertion length, and the characteristics of the product being measured; such as viscosity, coating, corrosion, conductivity and dielectric constant. When these properties are known, the factory will select the correct sensing element for the application.

Sensing elements are of two general types: immersion and proximity.

Immersion type sensing elements can be divided into two general categories, "insulated" and "non-insulated".

Non-insulated or "bare" immersion sensing elements have a bare metal probe to sense the product. These are commonly used when the product being measured is nonconductive and not highly corrosive. See Figure 2-3.

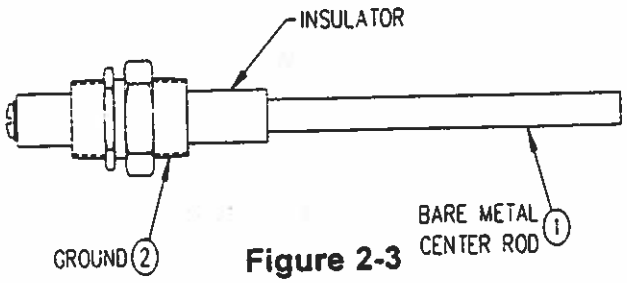


Figure 2-3
Bare Sensing Element

Insulated immersion sensing elements have the probe covered in an insulating material such as teflon. Insulated sensing elements may be used in applications measuring conductive or nonconductive products. See Figure 2-4.

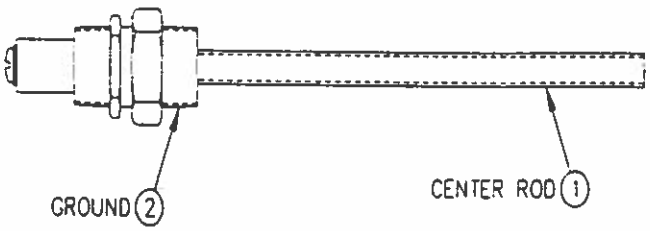


Figure 2-4
Insulated Sensing Element

Proximity-type sensing elements are used when it is necessary or desirable that the material being measured does not come in contact with the sensing element. See Figure 2-5.

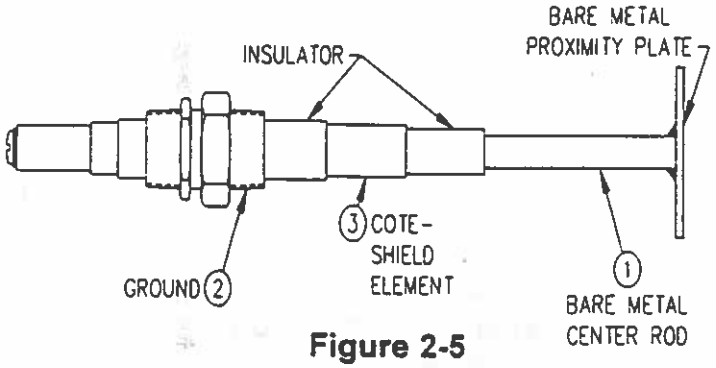


Figure 2-5
Three-Terminal Sensing Element
(Shown with Proximity Plate)

For long insertion lengths or where head clearance is a problem, flexible cable probes are also available in both insulated and bare metal models, as shown in Figure 2-6.

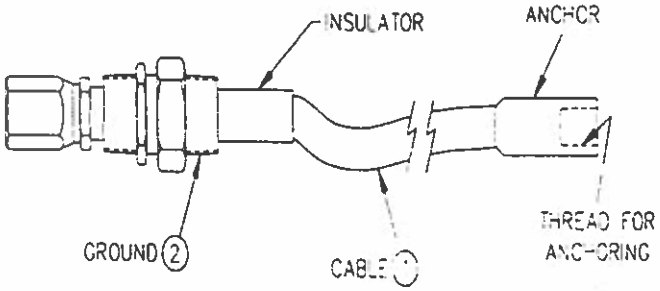


Figure 2-6
Flexible Cable Sensing Element

2.3 Connecting Cables (Optional)

In remote system applications, the Drexelbrook 508-4X-XX systems typically use a three-terminal coaxial cable to connect the sensing element to the electronic unit. The center wire of the cable carries the change in capacitance signal from the probe to the electronic unit, while the coaxial shield is driven at guard potential (sometimes called Cote Shield[TM]). The purpose of the shield is to eliminate any capacitance from the center wire to ground. As a result, the cable capacitance does not interfere with the capacitance signals from the probe. There is no need for the electronic unit to "zero out" the cable capacitance in order to get a reliable reading. The shield also prevents output errors due to changes in cable capacitance caused by temperature. See Figure 2-7.

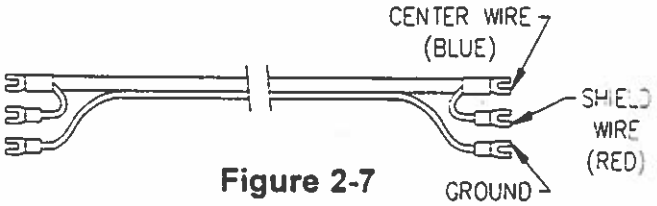


Figure 2-7
Typical Coax Cable (GRN)

SECTION 3 - INSTALLATION

3.1 Unpacking

Carefully remove the contents of the carton and check each item against the packing list before destroying any packing material. If there is any shortage or damage, report it immediately to the factory.

3.2 Mounting the Electronics

The 408-8200 Series system was designed for field mounting, but it should be mounted in a location as free as possible from vibration, corrosive atmospheres, and any possibility of mechanical damage. For convenience at start-up, mount the instrument in a reasonably accessible location. Ambient temperatures should be between -40°F and 140°F. (-40° and 60°C). See Figure 3-1.

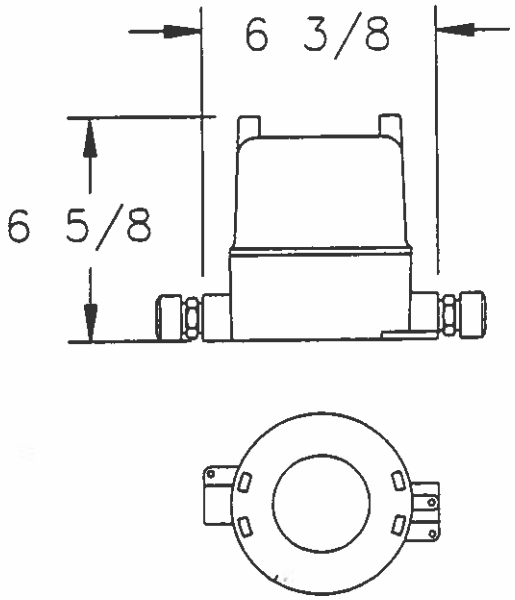


Figure 3-1B
Typical Mounting Dimensions
(Remote Unit)

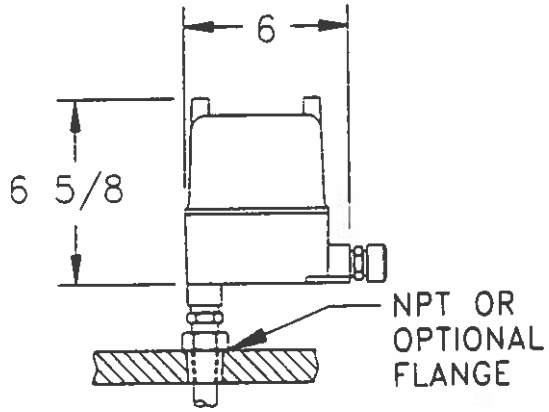


Figure 3-1A
Typical Mounting Dimensions
(Integral Unit)

3.3 Mounting the Sensing Element

The mounting location for the sensing element (probe) is often determined by the placement of nozzles or openings in the vessel. The sensing element should not be placed in a fill stream. When there is no suitable location inside a vessel, an external side arm or stilling well can be considered.
The following sensing element mounting and installation instructions should be followed so that the equipment will operate properly and accurately:

A. In applications requiring an insulated sensing element, use particular care during installation. There is always the danger of puncturing the insulating sheath, especially with the thin-walled, high capacitance probes.
B. Sensing elements should be mounted in such a manner that they are not in the direct stream of a filling nozzle or chute. If this is not possible, a deflecting baffle should be installed between the probe and the fill.

C. Do not take a sensing element apart or loosen the packing glands.

D. Tighten the sensing element with the wrench flats nearest the mounting threads.

CAUTION

Avoid using single-part RTV sealant in the probe or instrument housing. The single-part sealants frequently contain acetic acid and cause corrosion of circuit components. Special two-part sealants (non-corrosive) are available. Consult factory for types of recommended two-part sealants.

3.4 Wiring the Electronic Unit

The signal connections are made to the three terminal block on the front of chassis. Due to the low power consumption of the instrument, the wiring need only be light gauge (e.g. 20 AWG). See Figure 3-2 for proper connections. Twisted shielded pair cables are recommended for lengths over 200 feet.

The cable from the sensing element is connected to the black, four terminal strip on the back of the instrument chassis. See Figure 3-3. The cable connections are center wire (CW), ground (gnd), and shield (SH).

Only coaxial cables supplied by Drexelbrook Engineering Company should be used to connect the transmitter to the sensing element. Use of other cables can result in unstable calibration.

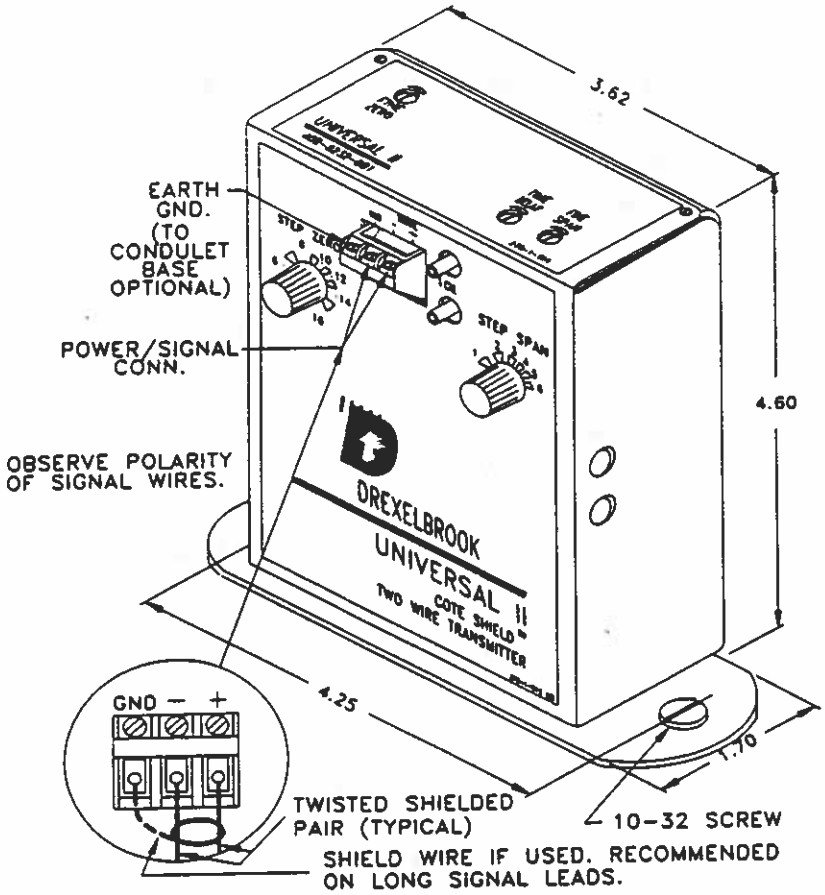


Figure 3-2
Power/Signal Connections

CAUTION

Before using Intrinsic Safety Barriers, read the manufacturers instructions for barrier operation. Barriers supplied by Drexelbrook Engineering Company, and prewired to the power supply, have already been tested for proper operation. See Figure 3-4.

The 408-8200 has a built-in current limiter which holds the signal current to a maximum of 28 mA. Make sure that the voltage applied to the barrier will not exceed the barrier voltage rating, if barriers are used.

3.4.1 Ground Wiring

The 408-8200 series transmitters have Radio Frequency Interference (RFI) filtering built into the unit. In order to be effective, The electronic unit condulet (housing) must be grounded to low impedance earth (ground) rod in the vicinity of the transmitter. The vessel wall also needs to be grounded to reduce interference through the sensor. If using a non-metallic vessel, consider concentrically-shielded sensors or external RFI filtering. Further, improvement is generally obtained by placing the sensor cable in a grounded metal conduit and shortening any excess cable. In particularly troublesome RFI situations, additional RFI filtering may be required. Contact the factory for more information.

3.4.2 Ground Wiring in Fiberglass Housings

When the transmitter is mounted in a fiberglass housing, be sure that an earth ground is carried through the fiberglass housing and put in contact with the "sprayed in" metallic coating on the inside of the housing. This coating provides additional RFI filtering. Additionally, the ground wire should be connected to the transmitter ground terminal. See Figure 3-2.

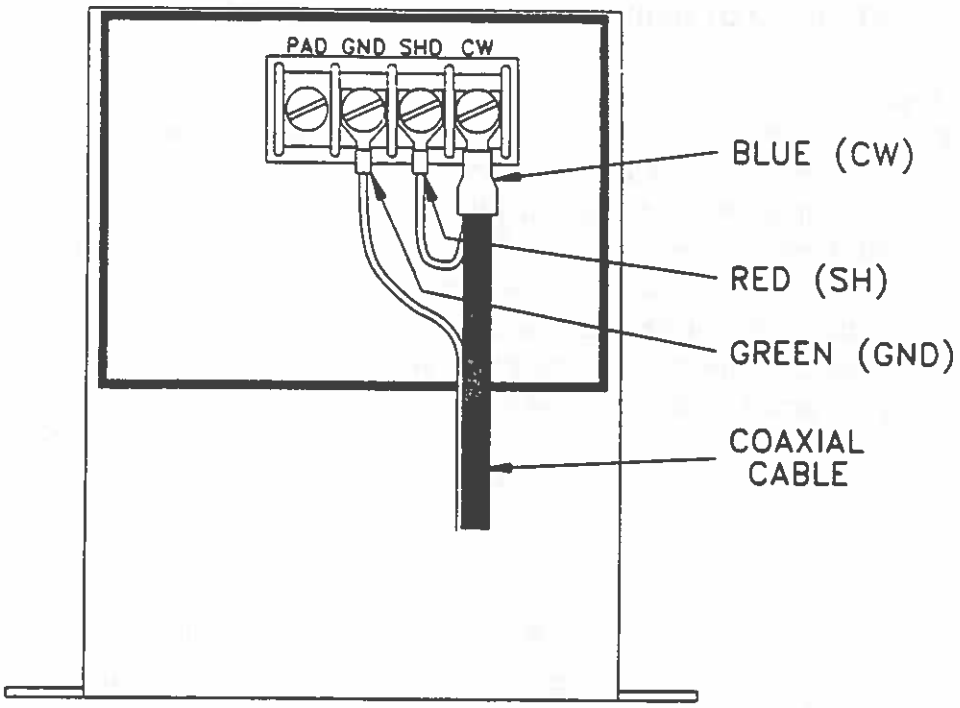


Figure 3-3
Cable Connections to the Transmitter

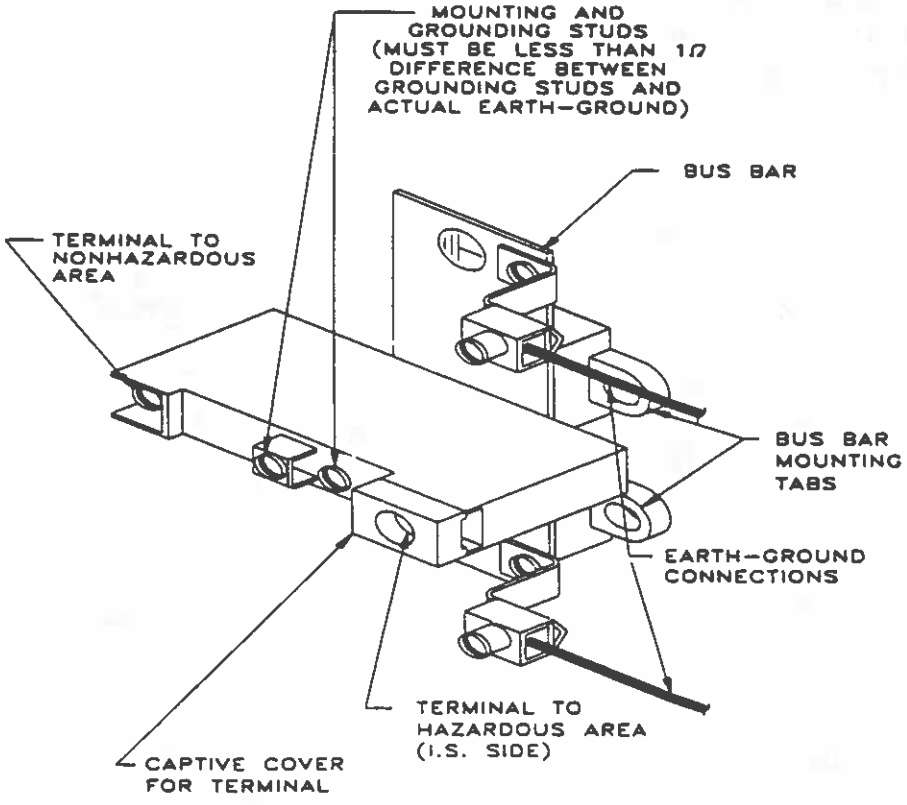


Figure 3-4
Typical Intrinsic Safety Barrier

3.5 Sensing Element Connections (Remote System)

The cable connections to the sensing element are shown in Figures 3-5A and 3-5B. Do not connect the cable to the sensing element until after the sensor has been installed in the vessel and the condulet housing has been screwed on securely. If your probe does not have a shield connection, be sure to clip and/or tape the shield wire at the probe end of the cable.

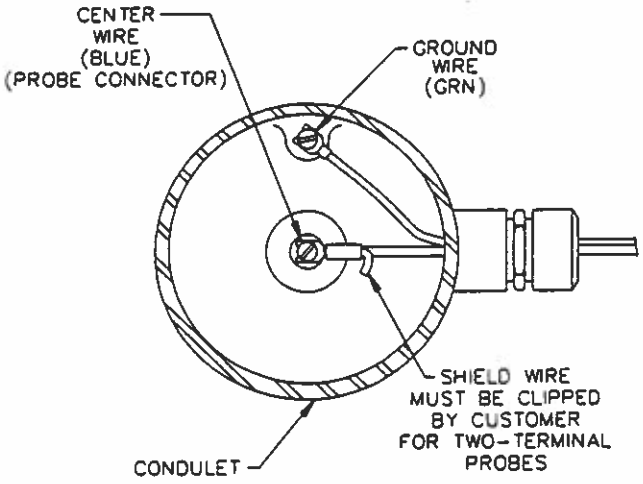


Figure 3-5A
Three-Terminal Cable Connections to Two-Terminal Sensing Element

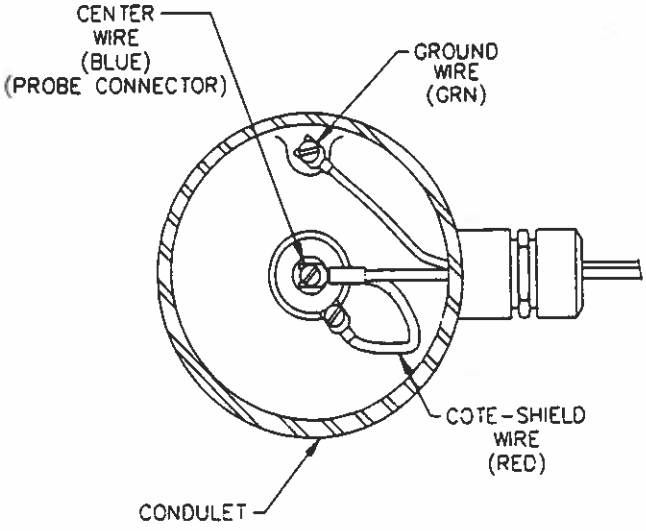


Figure 3-5B
Three-Terminal Cable Connections to Three-Terminal Sensing Element

If spark protection is supplied (for special applications, consult factory), use the following instructions for installing the spark protector in the sensing element condulet: (See Figure 3-6.)

A. Attach the mounting link on the spark protector to the probe center connection screw.

B. Connect the green wire from the spark protector to the ground screw.

C. Feed the cable into the condulet.

D. Connect the cable center wire (CW) to the spark protector and the ground wire (gnd) to the ground screw as shown.

E. Connect the shield wire to the Cote-Shield terminal (SH).*

*For sensing elements that Do not have Shield connections, clip the shield wire as shown in Figure 3-6.

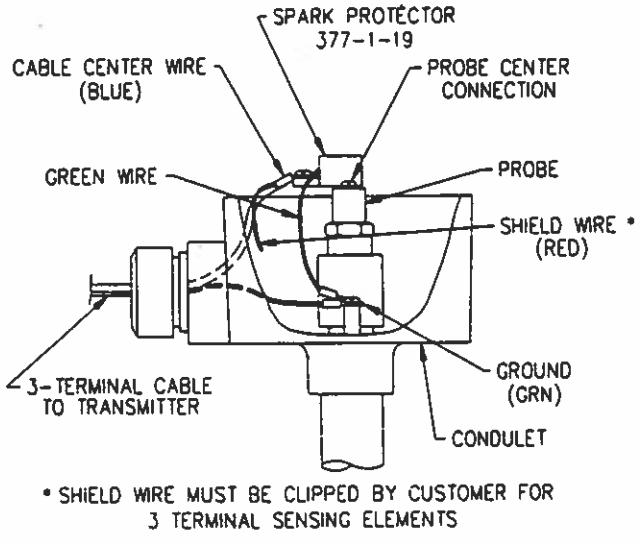


Figure 3-6
Typical Spark Protection (Remote System)

3.6 Sensing Element Connections (Integral System)

In an integral system, there is no cable. Therefore, the connections to sensing element are made directly to the electronic unit. Refer to Figures 3-7A and 3-7B.

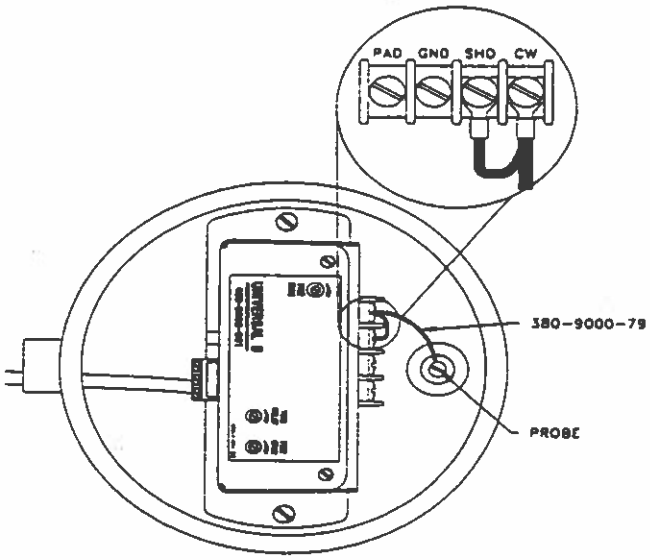


Figure 3-7A
Integral-Mount Sensing Element Connection

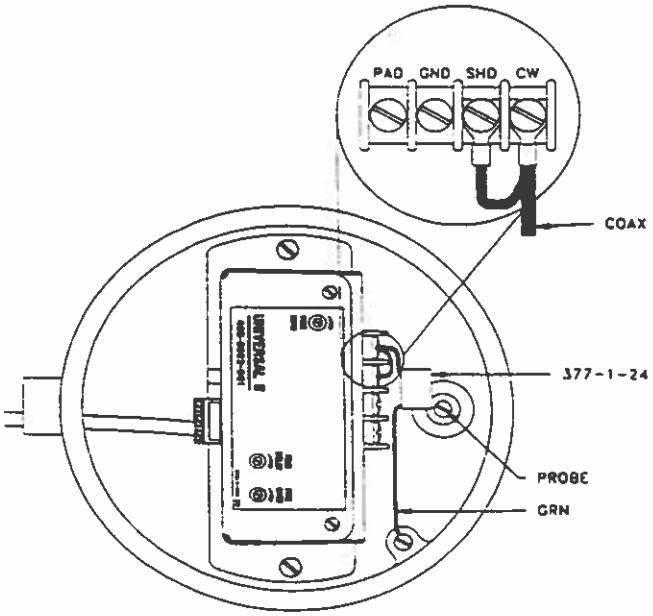


Figure 3-7B
Integral-Mount Sensing Element Connection with Spark Protection

3.7 Intrinsic Safety Barriers - Installation with Drexelbrook Continuous Instruments

A typical installation of a single intrinsic safety barrier is shown in Figure 3-8. A single barrier installation is usually rated for operation at 24-26V with a maximum of 80 mA. The barrier will typically start limiting the current at 26 mA. Drexelbrook recommends that a current-limiting, rather than a trip type barrier be used in the installation. The reason for this approach is that a trip-type barrier must be reset by breaking the loop power to reset the barrier. The inadvertent tripping often occurs during calibration. This condition does not occur with a current-limiting style barrier.

Single-Barrier Installations (Figure 3-8)

When using barriers, an important consideration is the overall loop resistance. Using a standard 24 Vdc power supply, the maximum loop resistance is 1200 ohms. Each 50 ohms in a loop uses 1 Vdc. A typical Drexelbrook transmitter requires a minimum of 11.5 Vdc, leaving 12.5 volts for the loop and a maximum load in the loop of 625 ohms. All of the loop resistance must be totaled to determine the remaining resistance that can be used by a barrier. Usually a "positive" barrier in a loop has a resistance of between 200 and 250 ohms, leaving approximately 400 ohms for other items in the loop.

2-Barrier Installations (Figure 3-9)

In certain instances, it is desirable that two barriers be used in an installation, such as when the signal is being fed to a microprocessor input card. A two-barrier installation allows the loop to float relative to ground. When this condition exists, it is very important that the loop resistance is checked to be sure that sufficient voltage is available

for correct transmitter operation. As shown in Figure 3-9, if two barriers are used, each having an internal resistance of 250 ohms, there would be only 125 ohms available for all other devices. To gain additional resistance, change the return (negative leg) barrier to a lower voltage type, e.g. rating of +6V. Normally the barriers have a resistance of approximately 12.5 ohms + 2V. By lowering the voltage type, the overall effective resistance would be 312.5 ohms, which allows an additional 312.5 ohms in the loop.

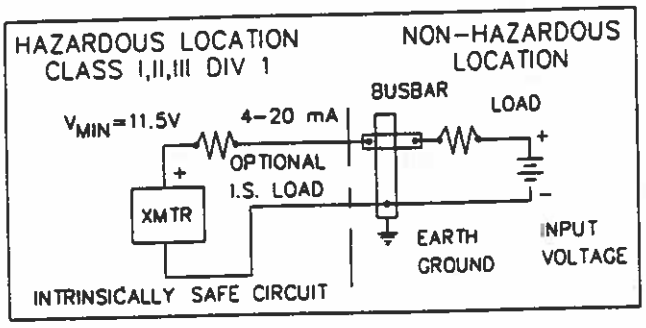


Figure 3-8
Single Barrier Installation

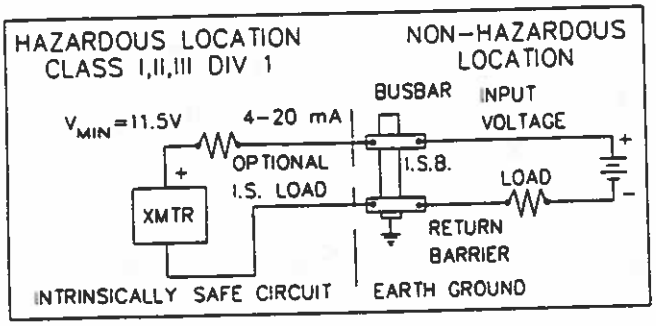


Figure 3-9
Two-Barrier Installation

SECTION 4 - CALIBRATION

4.1 Controls and Adjustments

4.1.1 Zero and Span Controls

There are two main controls on the chassis front panel. They are the Step Zero, and Step Span controls. The Fine Zero and Fine Span controls are located on the top of the chassis. See Figure 4-1.

The Step Zero and Fine Zero controls work together to provide continuous adjustment of the minimum current point. Each Step Zero position advances the minimum current point approximately 25 pF, while the Fine Zero provides continuous adjustment between each step.

NOTE

Under normal circumstances, the interaction between zero and span should be less than 1%. If this interaction becomes greater than 1%, consult factory for assistance.

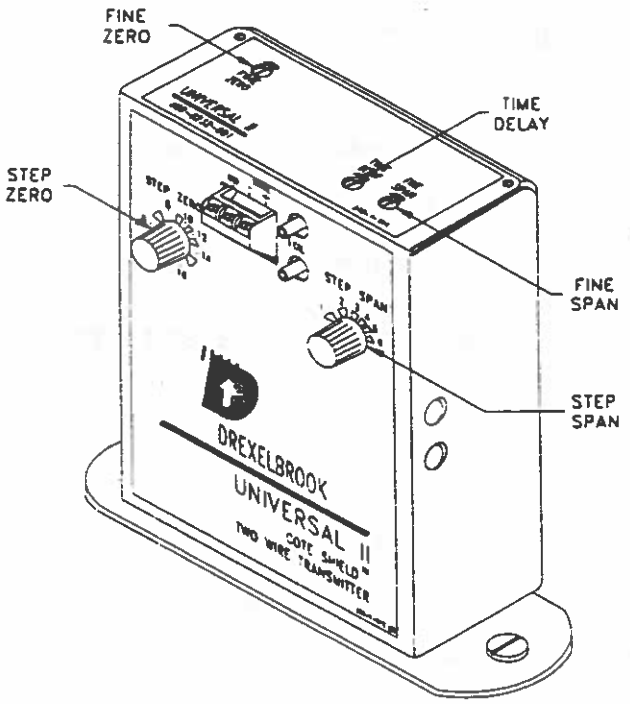


Figure 4-1
Zero and Span Controls

The Step Span and Fine Span controls also work together to provide continuous adjustment of the change in capacitance required to produce full scale current. Each Step Span position advances the range in inches or feet to approximately five times the previous setting. The Fine Span provides continuous adjustment between the Step Span positions.

4.1.2 Time Delay Control and Loop Current Testpoints

Time delay is standard on this transmitter. See Figure 4-2. It is an RC time constant circuit that is variable over a range of 0.5 to 30 seconds. For most applications requiring damping, five or ten seconds is usually sufficient. Calibration of the transmitter is done with the time delay turned off (full CCW).

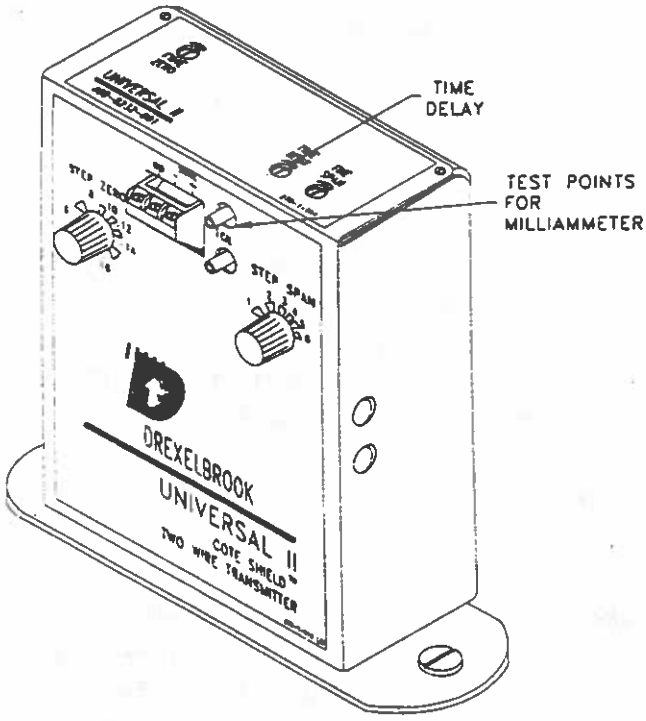


Figure 4-2
Time Delay Unit

After calibration is complete, a time delay can be added, without affecting the calibration, by turning the control knob clockwise. Occasionally, when the time delay is first turned on, there is a temporary upset in the transmitter output until the circuit settles out. Two testpoints are provided so that loop current can be monitored without breaking the loop with a standard analog or digital multimeter set to measure 0 to 20 mA.

4.1.3 Below-Chassis Adjustments

There are two adjustments in the chassis that are set by the factory and normally do not need to be changed. However, if necessary, they may be reset by field personnel. They are the fail-safe selector and a modification procedure for changing the 408-8202 to a 408-8232.

A. Fail-Safe Selector

The fail-safe selector determines whether increasing or decreasing level will cause the output current to increase. It is a movable link located on a printed circuit board on the inside of the chassis. See Figure 4-3.

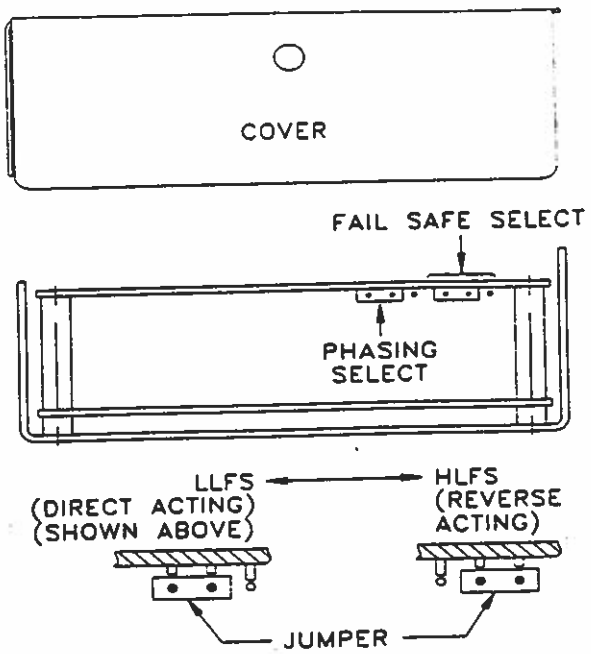


Figure 4-3
Fail-Safe Link

The instrument is supplied with the more common low-level fail-safe unless otherwise specified. Low Level Fail Safe (LLFS) provides increasing current signal with increasing level. (See description in subsequent paragraph.) The fail-safe can be changed in the field, after which the unit must be recalibrated.

To change the fail-safe of the instrument, take the chassis out of the condulet by turning the two captive chassis mounting screws CCW and lifting unit up. See Figure 4-4. Note position of switch knob pointer for proper re-assembly. Remove the two knobs using an allen wrench, then remove the two screws on the top of the unit to remove unit cover. Change the 3-terminal jumper that is closest to the bottom of the PC board as shown in Figure 4-3. When link has been changed, re-assemble unit cover and knobs and install unit in condulet.

Low-Level Fail-Safe is also called DIRECT-ACTING. This is the most commonly used fail-safe position FOR CONTINUOUS INSTRUMENTS. Output CURRENT INCREASES as the LEVEL INCREASES. (Exception being inverted interface, see Section 4.3.3). In the event of most probable failures, the output current will drop and indicate LOW LEVEL.

High-Level Fail-Safe is called REVERSE ACTING. Output CURRENT INCREASES as the LEVEL DECREASES. In the event of most probable failures, output current will drop indicating HIGH LEVEL.

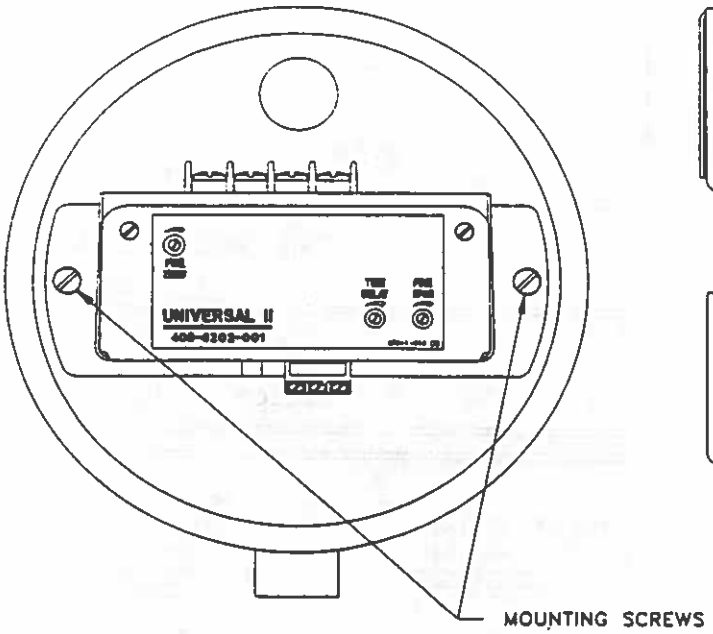


Figure 4-4
Electronic Unit in Typical Housing

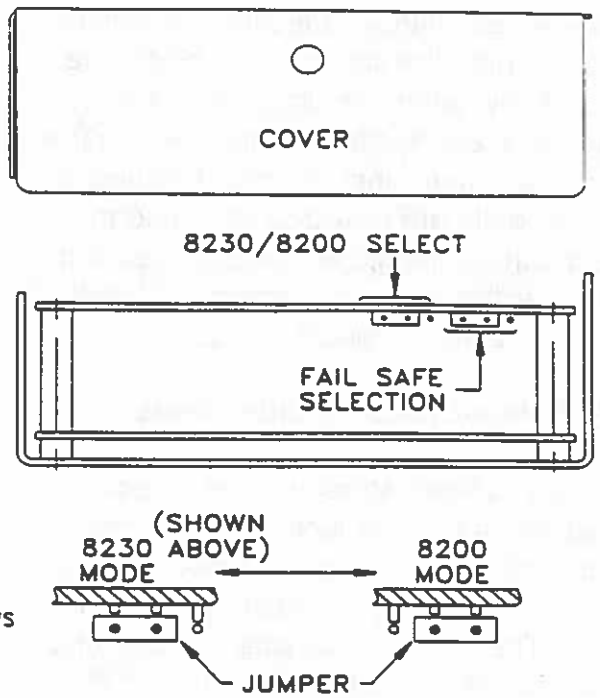


Figure 4-5
Modification Procedure for 408-8230

B. 408-8230-XX Modification Procedure

The following procedure can be used to modify a basic 408-8200 electronic unit to a 408-8230 electronic unit. See Figure 4-5. It should only be used when the application makes it necessary. Consult Factory.

Take the chassis out of the condulet by turning the two chassis mounting screws CCW and lifting unit up. See Figure 4-4. To change the modification link, remove the two knobs using an allen wrench, then remove the two screws on the top of the unit to remove unit cover. The modification link is the 3-terminal jumper nearest the middle of the PC board as shown in Figure 4-5. When modification link has been changed, re-assemble unit cover and knobs, and install unit in condulet. To convert a 408-8230 unit to a 408-8200 unit, follow the preceding instructions in reverse. After modification, recalibration (paragraph 4.4.2) should be performed.

4.2 Start-Up

Before applying power to the instrument, be sure that the input power will be from 11.5 to 50 VDC. Check all wiring connections, observing polarity of the output loop. (Unit will not function if polarity is reversed.

Caution: Explosionproof Units in Hazard ous Areas: Before the explosionproof condulet cover is removed to calibrate the instrument, the area must be checked and known to be nonhazardous if barriers are not used. When calibration is complete, replace the condulet cover. Each lead from the explosionproof case must be equipped with an approved seal fitting.

Avertissement: Risque D'Explosion: Avant de deconnector l'equipment, couper le courant ou s'assurer que l'emplacement est designe non dangereux.

After calibration is complete, a time delay can be added, without affecting the calibration, by turning the control knob clockwise. Occasionally, when the time delay is first turned on, there is a temporary upset in the transmitter output until the circuit settles out. Two testpoints are provided so that loop current can be monitored without breaking the loop with a standard analog or digital multimeter set to measure 0 to 20 mA.

4.1.3 Below-Chassis Adjustments

There are two adjustments in the chassis that are set by the factory and normally do not need to be changed. However, if necessary, they may be reset by field personnel. They are the fail-safe selector and a modification procedure for changing the 408-8202 to a 408-8232.

A. Fail-Safe Selector

The fail-safe selector determines whether increasing or decreasing level will cause the output current to increase. It is a movable link located on a printed circuit board on the inside of the chassis. See Figure 4-3.

The instrument is supplied with the more common low-level fail-safe unless otherwise specified. Low Level Fail Safe (LLFS) provides increasing current signal with increasing level. (See description in subsequent paragraph.) The fail-safe can be changed in the field, after which the unit must be recalibrated.

To change the fail-safe of the instrument, take the chassis out of the condulet by turning the two captive chassis mounting screws CCW and lifting unit up. See Figure 4-4. Note position of switch knob pointer for proper re-assembly. Remove the two knobs

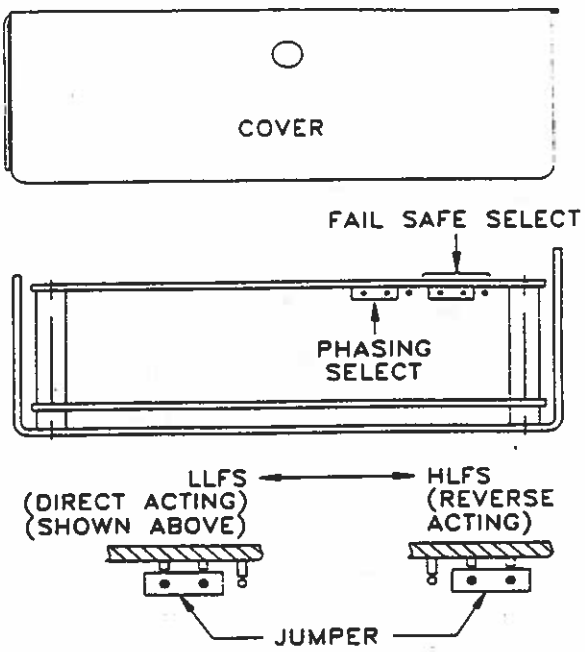


Figure 4-3
Fail-Safe Link

using an allen wrench, then remove the two screws on the top of the unit to remove unit cover. Change the 3-terminal jumper that is closest to the bottom of the PC board as shown in Figure 4-3. When link has been changed, re-assemble unit cover and knobs and install unit in condulet.

Low-Level Fail-Safe is also called DIRECT-ACTING. This is the most commonly used fail-safe position FOR CONTINUOUS INSTRUMENTS. Output CURRENT INCREASES as the LEVEL INCREASES. (Exception being inverted interface, see Section 4.3.3). In the event of most probable failures, the output current will drop and indicate LOW LEVEL.

High-Level Fail-Safe is called REVERSE ACTING. Output CURRENT INCREASES as the LEVEL DECREASES. In the event of most probable failures, output current will drop indicating HIGH LEVEL.

Calibration is now complete. Record the capacitance values that produce 4 mA and 20 mA outputs. Refer to paragraph 4.4.1 to use a capacitance calibration standard.

B. Immersion - Reverse Acting (HLFS) (Output falls as material rises.)

1) Set the Fail-Safe link in the "REV" position See Section 4.1.3.

2) Set Fine Span and Fine Zero controls to extreme counterclockwise position. See Figure 4-7.

3) Set Step Span and Step Zero to Position #1.

4) With the material at the upper operating level, adjust the Step and Fine Zero controls until the output is 4 mA. For this calibration procedure, a compensation capacitor is usually required to obtain the minimum 4mA output. It will be added by the factory when the application is known. If needed and not supplied, add-in 100 pF steps: an NPO capacitor across Terminals PAD and CW until the minimum output can be obtained. See Figure 4-10 or call factory service for value.

5) Lower the material to the minimum operating level. Output current will exceed full scale.

6) Turn the Step Span control clockwise until the output is less than full scale. (If current did not exceed full scale in Step 5), leave Step Span in Position #1).*

7) Turn the Fine Span control clockwise until the level is full scale (20 mA) or actual level.*
Calibration is now complete.

*If output is less than full scale, a higher sensitivity instrument may be required. Consult factory.

4.3.2 Proximity Applications

In applications where the product being measured is an insulator, it may be necessary to install a ground plate just below the product lower level. This ground plate should be at least 25% larger than the sensing plate and electrically connected to ground. The ground plate need not be a solid plate. It could be a series of rods, spaced apart, enclosing the same areas as a plate. Consult factory.

There are two different methods for calibrating your instrument for a proximity application. See Figure 4-8. Set the instrument for either low-level or high-level fail-safe.

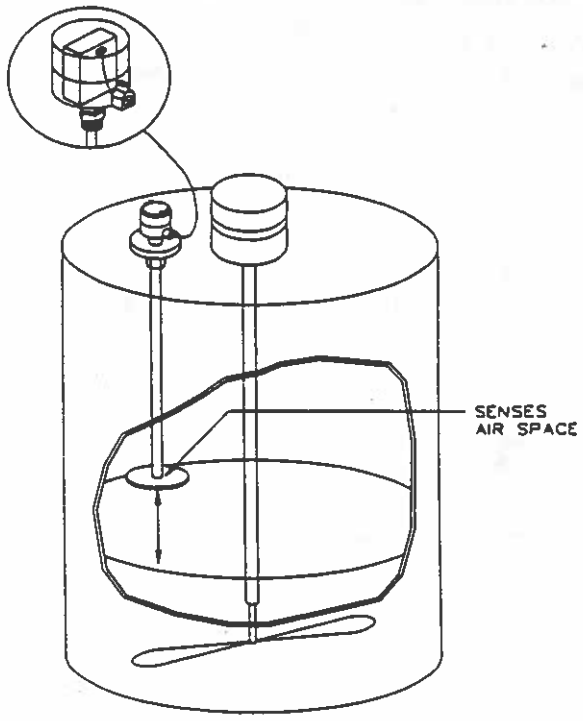


Figure 4-8
Proximity Application

A. Proximity - Direct Acting (LLFS) (Output rises as material rises.)

1) Be sure fail-safe link is in "DIR" position. See Section 4.1.3.

4.3 Calibration Procedures

NOTE

If the transmitter has been precalibrated at the factory, do not recalibrate.

The calibration instructions for the 408-8200 Series transmitter are divided into three major application categories with different methods in each category.

The three calibration categories are immer sion applications, proximity applications, and interface applications.

4.3.1 Immersion Applications (See Figure 4-6)

A. Immersion - Direct Acting (LLFS) (Output rises as material rises.)
Calibrating the instrument in an immersion application for low-level fail-safe is the most commonly used method.

1) With fail-safe link in "DIR" position, (factory pre-set unless unit is ordered high level, see Section 4.1.3), set Fine Zero and Fine Span to extreme counterclockwise position. See Figure 4-7.

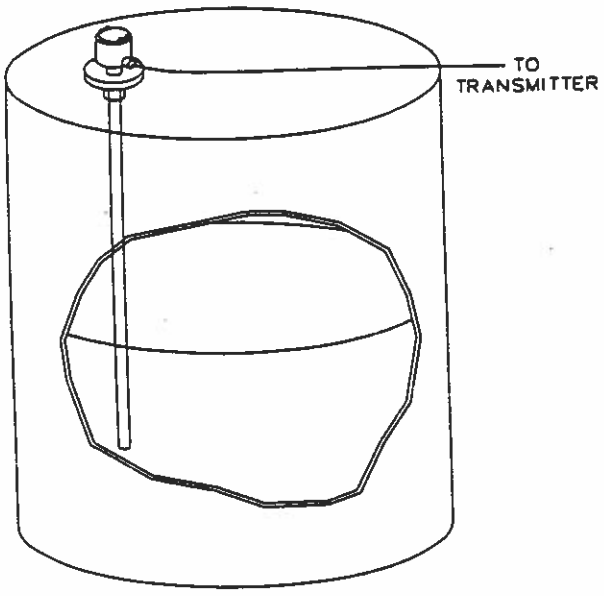


Figure 4-6
Immersion Application

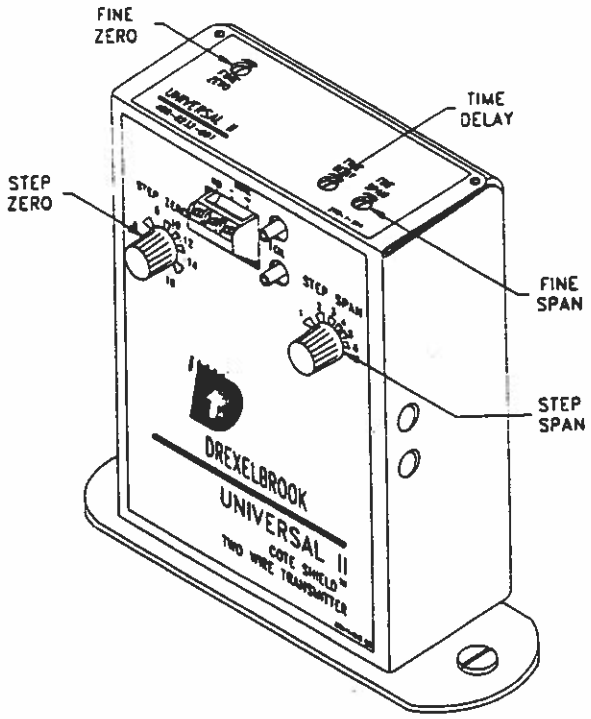


Figure 4-7
Zero and Span Controls

2) Set Step Span and Step Zero to Posi- tion #1.

3) With the vessel empty (or probe uncov- ered), adjust the Step Zero control clock- wise, if necessary, until the output is less than 4 mA.

4) Turn Fine Zero control clockwise until output is exactly 4 mA.

5) Fill the vessel (or raise the level as much as possible). Output current will now ex- ceed full scale current.

6) Turn the Step Span control clockwise until the output is less than full scale. (If current did not exceed full scale in Step 4), then leave Step Span in Position #1.)

7) Turn the Fine Span control clockwise until the output is full scale (20 mA) or reading actual level.

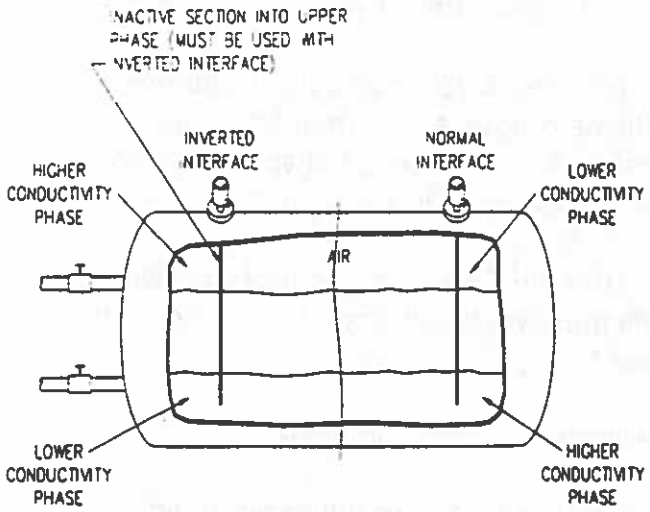


Figure 4-9
Interface Application

A. Normal Interface-Direct Acting (LLFS)

1) Set fail-safe link to "DIR" position (see Section 4.1.3) and set Fine Span to extreme counterclockwise position. Do not force. See Figure 4-7.

2) Set Step Span to Position #1.

3) Lower the interface level until the probe (or its lowest level) is covered with only the upper phase, insulating material. Set the Step and Fine Zero controls until the output is minimum (4 mA).

4) For this calibration procedure, a compensation capacitor may be required to obtain the minimum 4 mA output. It will be added by the factory when the application is known. If needed and not supplied, add - in 100 pF steps - an NPO capacitor across Terminals PAD and CW until the minimum output can be obtained. See Figure 4-10 or call factory service for value.

5) Raise the interface until most of the lower, waterlike phase of material is covering the probe (or its highest level). Output current will now normally exceed full scale.

6) Turn the Step Span control clockwise until the output is less than full scale. (If current did not exceed full scale in Step 5, then leave Step Span in Position #1).

7) Turn the Fine Span control clockwise until the output is equal to the actual interface level on the probe.

Calibration is now complete.

B. Normal Interface - Reverse Acting (HLFS)

1) Set the fail-safe link to the "REV" position (see Section 4.1.3) and set the Fine Span control to the extreme counterclockwise position. See Figure 4-7.

2) Set the Step Span to Position #1.

3) Raise the level until the lower phase, conducting material is covering the probe (or its highest level). Adjust the Step and Fine Zero controls until the output is minimum (4 mA).

4) If 4 mA cannot be obtained, add a padding capacitor equal to or less than 1/4 the full scale capacitance of the probe in the upper phase. This capacitor will be added across Terminals PAD and CW by the factory when the application is known. See Figure 4-10.

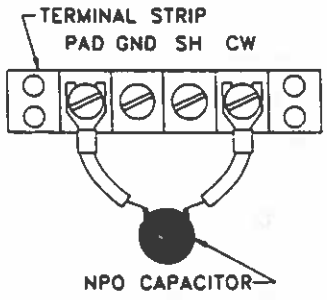


Figure 4-10
NPO Capacitor Connections

2) Set Fine Span and Fine Zero controls to extreme counterclockwise position. Do not force. See Figure 4-7.

3) Set Step Span and Step Zero to Position #1.

4) With the material at the lower operating level, adjust the Step and Fine Zero controls until output is minimum (4mA).

5) Raise the material to the upper operating level, but not touching the probe plate. Output current will now exceed full scale current.

6) Turn the Step Span control clockwise until the output is less than full scale. (If current did not exceed full scale in Step 5, leave Step Span in Position #1).*

7) Turn the Fine Span control clockwise until the output is full scale (20 mA) or actual level.*

Calibration is now complete. (Note that proximity applications are non-linear.)

*If output is less than full scale, a higher sensitivity instrument may be required. Consult factory.

B. Proximity - Reverse Acting (HLFS) (Output falls as material rises.)

1) Be sure Fail-Safe link is in "REV" position. See Section 4.1.3.

2) Set Fine Span and Fine Zero controls to extreme counterclockwise position. Do not force. See Figure 4-7.

3) Set Step Span to Position #1.

4) With the material at the upper operating level (but lower than the probe plate), adjust the Step and Fine Zero controls until the output is minimum (4 mA).

5) Lower the material to the lower operating level. Output current will exceed full scale.

6) Turn the Step Span control clockwise until the output is less than full scale. (If current did not exceed full scale in Step 5), leave Step Span in Position #1).*

7) Turn the Fine Span control clockwise until the level is full scale (20 mA) or actual level.*

Calibration is now complete.

*If output is less than full scale, a higher sensitivity instrument may be required. Consult factory.

4.3.3 Interface Applications

All level control applications are actually interface measurements. The most common being the interface of air and product. The term interface generally refers to the interface of two immiscible liquids (liquids that don't mix).

For the purpose of level control, two types of interface are considered. The first and more common is called normal interface. An interface is considered "normal" when the lower product has the higher conductivity (i.e. oil and water). The other type of interface is called inverted interface. In an inverted interface, the upper-phase product has the higher conductivity, indicating the insulating phase is heavier than water.

There are four separate methods for calibration in interface applications. (See Figure 4-9.) They are normal interface in either high- or low-level fail-safe, and inverted interface in high- and low-level fail-safe.

4.4 Secondary Calibration Standard

In some applications, it is difficult or even impossible to completely fill or empty a vessel. In such a case, it is desirable to have a secondary calibration standard such as the Drexelbrook Model 401-6-8, which can be used to simulate the capacitance of an empty or full vessel. The following procedure permits recalibration of an instrument without the necessity of emptying the vessel. Figure 4-11 shows a typical calibration standard. Refer to the calibration standard manual (401-6-8) for proper connection and operation.

4.4.1 Recording Calibration Data

After initial calibration, do the following: (Also, see instruction manual for calibration standard.)

A. Disconnect the probe wire.

B. Connect the calibration standard to the instrument. See Figure 4-11.

C. Adjust the calibration standard until the instrument indicates minimum current (4mA).

D. Record the value read on the calibration standard and its serial number for later use.

E. Adjust the calibration standard until the instrument indicates maximum current (20 mA).

F. Record the capacitance value as in Step D.

G. Disconnect the calibration standard from the instrument terminals and reconnect the probe.

4.4.2 Recalibration

Whenever it is subsequently desired to check or reset the calibration, or replace the instrument, the calibration capacitor set to the value recorded above may be substituted for the probe. Proceed as follows:

A. Disconnect the probe wire.

B. Connect the calibration standard to the instrument. See Figure 4-11.

C. Set the calibration standard to the recorded values.

D. If necessary, adjust the zero control for the minimum current calibration and the span control for the maximum current calibration.

E. Disconnect the calibration standard and reconnect the probe wire to probe.

Unit is again ready for operation.

When replacing a malfunctioning electronic unit, the replacement chassis can be calibrated on the bench by the preceding method and then installed in the field.

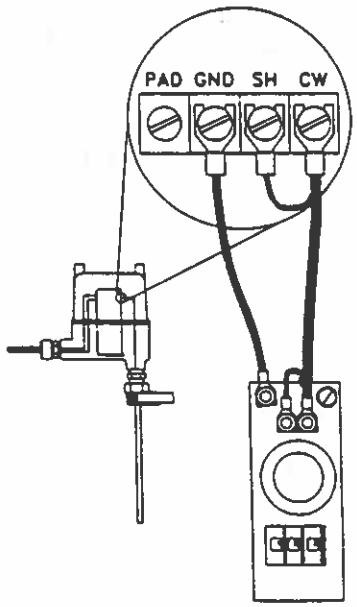


Figure 4-11
Calibration Standard

5) Lower the interface until only the upper phase, insulating material is covering the probe (or its lowest level). Output current will now normally exceed full scale.

6) Turn the Step Span control clockwise until the output is less than full scale. (If current did not exceed full scale in Step 5, then leave Step Span in Position #1).

7) Turn the Fine Span control clockwise until the output reads the correct interface level.

Calibration is now complete.

C. Inverted Interface-Direct Acting(LLFS)

1) Move fail-safe link to "REV" position, not "DIR". See Section 4.1.3.

2) Set the Step Span control to Position #1 and Fine Span in the full counterclockwise position. See Figure 4-7.

3) Lower the level until the probe (or its lowest level) is covered with only the con ducting, upper phase material.

4) Set the Step and Fine Zero controls until output is minimum (4 mA).

5) If 4 mA cannot be obtained, add a pad-ding capacitor equal to or less than 1/4 the full scale capacitance of the probe in the upper phase. This capacitor will be added across Terminals PAD and CW by the factory when the application is known. See Figure 4-10.

6) Raise the interface until most of the lower insulating phase of the material is covering the probe (or its highest level). Output current will now normally exceed full scale current.

7) Turn the Step Span control clockwise until the output is less than full scale. (If output current did not exceed full scale in Step 6), then leave Step Span in Position #1).

8) Turn the Fine Span control clockwise until the output is equal to level of lower phase material covering the probe.

Calibration is now complete.

D. Inverted Interface-Reverse Acting (HLFS)

1) Set fail-safe link to Low-Level Fail-Safe position, not High Level. See Section 4.1.3.

2) Set the Step Span control to Position #1, and the Fine Span in the full counter clockwise position. See Figure 4-7.

3) Raise the interface to the desired upper level.

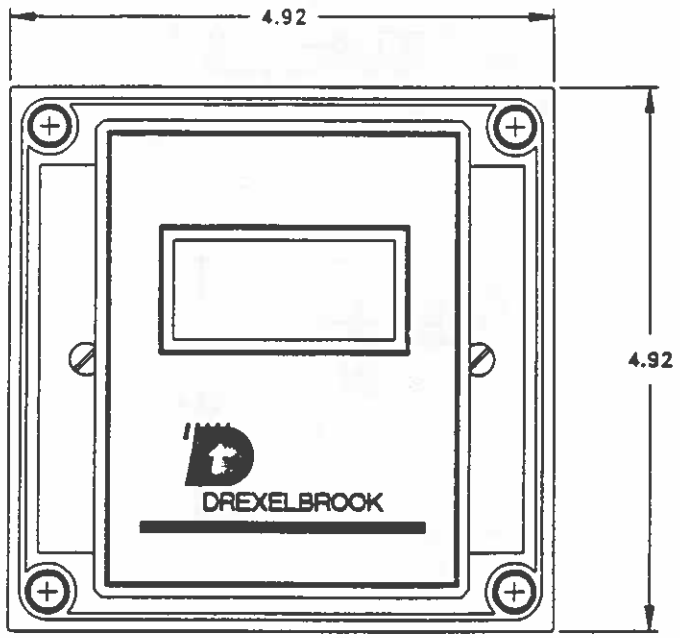
4) Adjust the Step and Fine Zero con-trols until the current output is minimum (4 mA).

5) If 4 mA cannot be obtained, add a padding capacitor equal to or less than 1/4 the full scale capacity of the probe in the lower phase. This capacitor will be added across Terminals Pad and CW by the factory when the application is known. See Figure 4-10.

6) Lower the interface to the desired lower level. Output current will now normally exceed full scale.

7) Turn the Step Span control clockwise until the output is less than full scale. (If output current did not exceed full scale in Step 6), then leave Step Span in Position #1).

8) Turn the Fine Span control clockwise until the output is full scale (20 mA) or actual level.
Calibration is now complete.



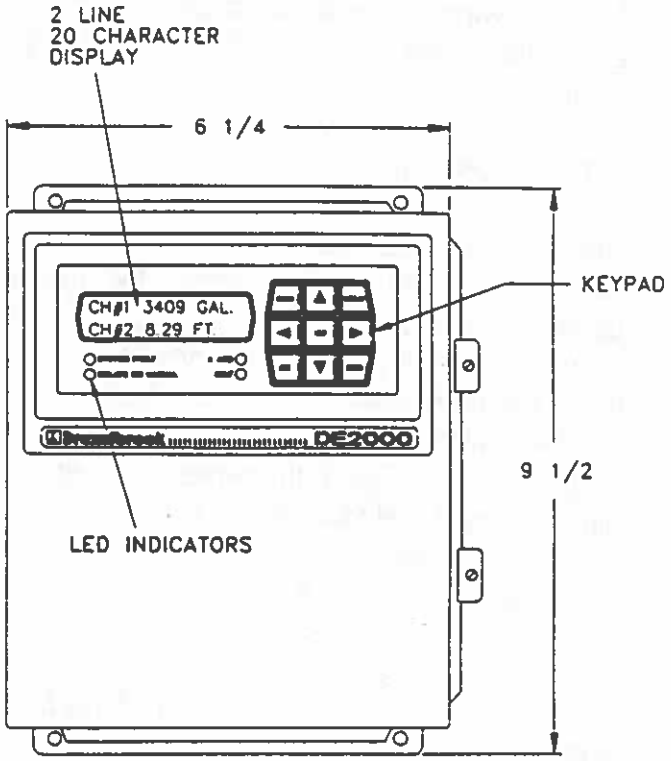


Figure 5-3
DE2000 Microprocessor Receiver

5.4 Meter/Power Supply/Setcon Packages

Drexelbrook also manufactures a Series 401-8100 and 401-8200 package that provide in various combinations, meters, power supplies, and current trips (SetconsTM) in the same housing.

5.5 Microprocessor Receivers

The DE2000 and DE8000 Microprocessor Receivers accept up to two and eight 4-20 mA inputs, respectively. The receivers provide setpoint and relay capabilities for audible and visual alarms and an RS-485 interface for integrated communications. In addition, the microprocessor provides the user with the advantages of keypad calibration, tank strapping, advanced diagnostics, and a non-volatile memory. Figure 5-3 shows a DE2000 Microprocessor Receiver.

SECTION 5 - ACCESSORIES

The following Drexelbrook accessories are available for use with the 508-4X-XX Series system.

5.1 Setcon (TM)

Setcon is a Drexelbrook trade name for a current-operated setpoint relay. It is often used with continuous instruments to provide an on/off output at a specific position along the transmitters 0-100% range. Setcons are available in double pole, double throw relay output models, field adjustable to either high- or low-level fail-safe. The relay contacts can be used to operate an alarm, solenoid valve, or other device.

The Setcon's standard differential, or deadband, is approximately .5% of the 0-100% setpoint range. There is an adjustable differential model with a deadband range of 0-100%, as well as the setpoint range of 0-100% of full scale.

Setcons are available in weatherproof and explosionproof housings or chassis only for mounting in various prewired case option packages.

5.2 Power Supplies

Drexelbrook power supplies are available in 24 VDC or 45 VDC models. See Figure 5-1. The power supply takes a typical 115 VAC* input and converts it to the 24 VDC (or 45 VDC).

The Drexelbrook 24 VDC model has an auto-restart feature. The auto-restart power supply will shut itself off when an excessive current fault occurs. It then tries to turn back on until the fault is cleared. This feature is particularly useful when feeding SCR-type intrinsic safety barriers.

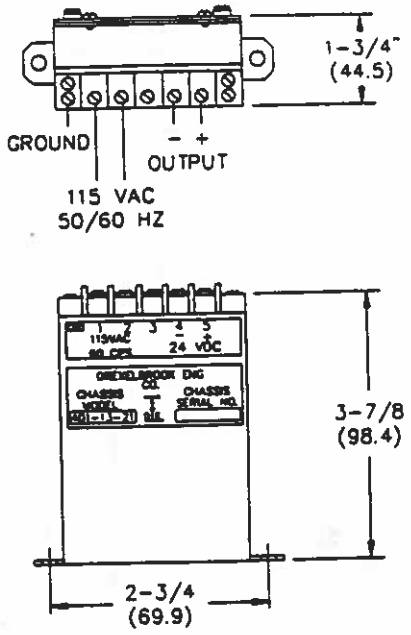


Figure 5-1
Typical Power Supply

Power supplies are available in weather proof and explosionproof housings, chassis only, or included in line-powered transmitters.

*240 VAC power supplies are also available.

5.3 Meters

The standard Drexelbrook digital meter is a 3.5-digit, .5-inch high liquid crystal display. It is powered directly from the 4-20 mA two-wire loop current. They can be purchased as meter only, in either weatherproof, NEMA 4, or explosionproof housings, or included in indicating transmitter housings. The digital meters can be calibrated to show percent of level, current or Engineering Units. See Figure 5-2.

6.2.2 Drift Check

If the output of a transmitter seems to be drifting, it is important to determine whether the drift is in the transmitter or in the probe. (A properly connected cable/probe never drifts.)

A. Remove the sensing element cable from the transmitter.

B. Without disturbing the dial settings, connect a capacitance standard or an NPO capacitor* across the probe to ground input. Adjust the capacitance standard or select a capacitor value that will bring the unit on scale (preferably around 50%).

*NPO capacitor remains stable with changes in temperature.

C. Record meter reading.

D. Observe the reading over a 24-hour period to see if it is stable.

E. If the reading is stable, the sensing element or the application must be the source of the drift. If the reading drifted, return the instrument for repair. Be sure to mark on the tag that the problem is drift. (List the capacitor size and mA deviation.)

F. Measure the resistance between the two wires that were just removed from (+) and (-) terminals of the electronic unit. Use the following table to determine if the resistance is too large.

$$R_{max\ \Omega} = \frac{V_{supply} - 11.5\ volts}{0.02\ amps}$$

Table 6-1
Minimum Allowable Resistance

V(SUPPLY) (VOLTS)	MAXIMUM LOOP RESISTANCE (OHMS)
50	1925
40	1425
30	925
24	625
20	425
18	325
12	25
11.5	0

6.3 Checking the Sensing Element

A. With an analog ohmmeter*, check the resistance of the probe-to-ground with level below the probe. See Figure 6-2.

*A digital ohmmeter may produce erroneous readings.

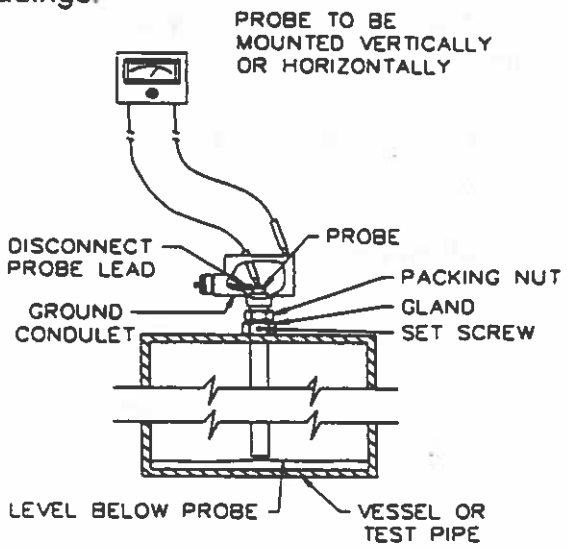


Figure 6-2
Testing the Sensing Element with Level Below the Probe

Resistance should be infinite. Resistance less than 1 megohm indicates leakage, probably due to product or condensation in the condulet, around the gland/packing nut area. Resistance of less than 100K ohms can cause errors in the reading. Consult factory service.

SECTION 6 - TROUBLESHOOTING

6.1 Introduction

The 408-8200 Series instruments are designed to give years of unattended service. No periodic or scheduled maintenance is required.

A spare chassis is recommended for every 10 units so that, in case of a failed unit, a critical application will not be held up while the unit is returned to the factory for repair.

If a difficulty occurs when operating your measurement system, mentally divide the system into its component parts and test each part individually for proper operation.

These troubleshooting procedures should be followed in checking out your system. If attempts to locate the difficulty fail, notify your local factory representative or call the factory direct and ask for the service department.

6.2 Testing the 408-8200 Series Electronic Unit

6.2.1 Operation Check

A. Remove the sensing element and signal wires from the transmitter.
B. Be sure Fail-Safe link is in low-level fail-safe position. See Figure 4-3.

C. With pencil, mark the positions of all controls on the faceplate in order to return to them.

D. Put the Step Span in Position #1 and the Fine Span in the full clockwise position. Put the Step Zero in Position #1 (most sensitive position). See Figure 4-1.

E. Observing polarities, connect a DC milliammeter and DC power supply (11.5 to 50 volts) in series, and complete the loop by connecting Terminals (-) and (+). See Figure 6-1.

F. Adjust the Fine Zero until the meter reads 0% (4 mA).

G. Turn the Fine Zero one clockwise turn further. The output should read approximately between 33% and 100% (9-20 mA).

If so, the instrument is probably working correctly. Each turn of the Fine Span changes the input a known amount. This checks the operation and gain of the transmitter.

H. If the difficulty has not been located at this point, proceed to the output checkout procedure in paragraph 6.3.

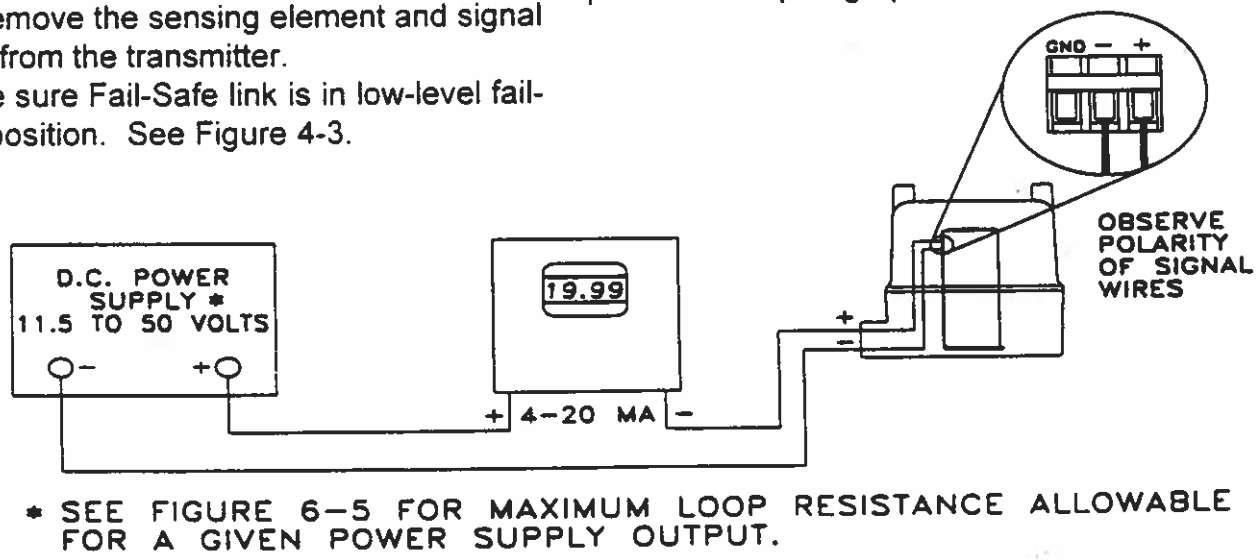
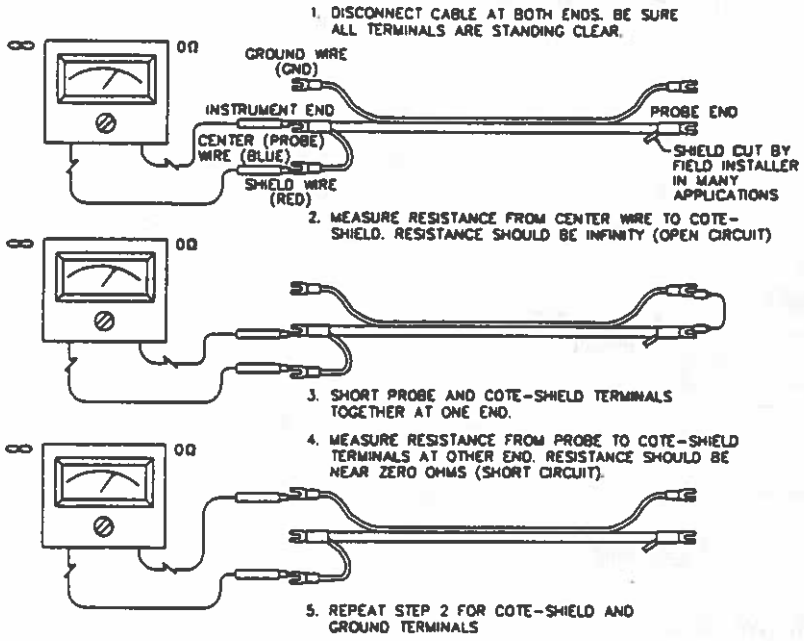


Figure 6-1
Power/Signal Wiring

6.4 Checking the Sensing Element Cable



B. Check the resistance of the probe-to-ground with level above the probe. See Figure 6-3. Resistance readings less than 100K ohms indicate either defects in the probe insulation or, if a bare probe, that the material is conductive and an insulated probe may be required. (Consult factory.)

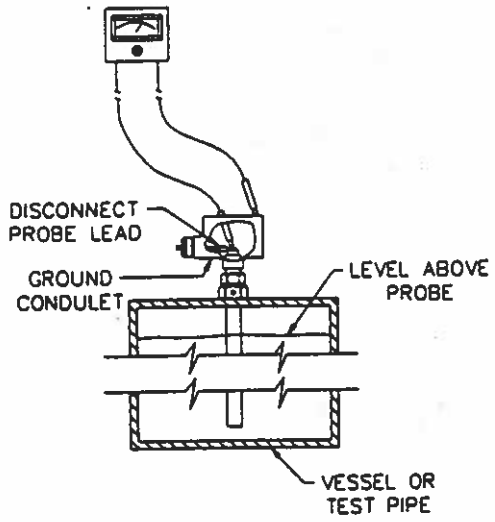


Figure 6-3
Testing the Sensing Element with Level Above the Probe

C. Coating error is characterized by high output with failing level, and a sharp drop to 0% when the material goes below the tip of the probe. To verify a coating problem, wipe the coating off the probe and recheck instrument operation. If the instrument reads correctly after cleaning, consult the factory for the best solution to the problem.

D. If a three-terminal sensing element is used, check resistance between center wire/shield and shield/ground. If readings are below 100K ohms, consult factory service.

6.6 List of Some Possible Problems and Causes

Problem	Possible Cause	Checkout
1. Transmitter reads 20 mA or greater even when vessel is not full.	a. Transmitter malfunction	a. Sec. 6.2.1
	b. Water in probe condulet	b. Sec. 6.4
	c. Short in cable	c. Sec. 6.4
	d. Cut in probe insulation	d. Sec. 6.4
	e. Calibration is wrong	e. Sec. 4.3
2. Transmitter never reaches 20 mA even though the vessel is full, or the output reading is nonlinear at the upper end of the scale.	a. Load resistance too high	a. Sec. 6.2.2
	b. Calibration is wrong	b. Sec. 4.3
	c. Transmitter malfunction	c. Sec. 6.2.1
3. Transmitter is drifting.	a. Moisture in probe gland	a. Sec. 6.3
	b. Water in probe condulet	b. Sec. 6.4
	c. Transmitter malfunction	c. Sec. 6.2.2
	d. Water in cable	d. Sec. 6.4
	e. Cut in probe insulation	e. Sec. 6.4
	f. Calibration is wrong	f. Sec. 4.3
	g. Material properties are changing	g. Consult factory
4. Transmitter is erratic. Output reading jumps anywhere from 0% to 100%.	a. Radio frequency interference	a. Need RFI filters.
	b. Cut in probe insulation	b. Sec. 6.4
	c. Waves in the liquid	c. Sec. 4.1.2
5. Transmitter was shipped precalibrated but is not reading correct level.	a. Wrong precalibration information supplied to factory	a. Verify precal information
	b. Nozzle or pipe around probe is not specified on precalibration sheet	b. Need to include info. on nozzle for precal
	c. Accuracy being checked by measuring outage as a % of full tank	c. Note: The zero point is at end of probe, not bottom of tank
6. Probe installed in stilling well, and readings are incorrect.	a. Probe touching stilling well	a. Adjust mounting
	b. Reading lower than actual level: Air trapped in stilling well	b. Put holes in stilling well to allow air to escape.
	c. Calibration is wrong	c. Sec. 4.3
	d. Material in stilling well may be interfacing	d. Consult factory
	e. If plastic, may cause non-saturation of probe	e. Consult factory
7. As level increases, output reading decreases.	a. Fail-safe in HLFS position	a. Sec. 4.1.3
	b. Transmitter malfunction	b. Sec. 6.2.1
8. Transmitter reading 5% to 10% or greater in error.	a. Conductive buildup on probe	a. Sec. 6.4 Consult Factory
	b. Calibration is wrong	b. Sec. 4.3
9. Erratic or incorrect readings.	a. Ungrounded conducting liquid in a fiberglass vessel	a. Instrument may need a ground. Consult factory.
10. Output current reading less than 3.5 mA	a. Wiring short from shield-to-ground, probably in probe head	a. Sec. 3.5
	b. Probe not connected to transmitter	b. See 3.5 or 3.6

6.5 Checking the Two-Wire System Loop

A. See Figure 6-4. Disconnect the power from (+) and (-) terminals and measure the open circuit voltage from the power supply. Voltage should be equivalent to source voltage.

*SeeTable 6-1 for minimum allowable voltage.

B. Connect the signal wires to (+) and (-) terminals . Turn the Step Span and Step Zero to Position #1. Put Fine Span control completely clockwise and adjust the Fine Zero until 20 mA flows.

C. Measure the voltage between (+) and (-) terminals. Voltage should be between 11.5 and 50 VDC. If there is less than the minimum 11.5 volts required, the loop has too much resistance or not enough power supply voltage.

D. If, in Step C above, the voltage is less than 11.5 VDC, disconnect the power supply and signal wires to the unit. Short the wires that were removed from the power supply (+) and (-) terminals.

Note: If there are active devices in the loop, the resistance can be very high.

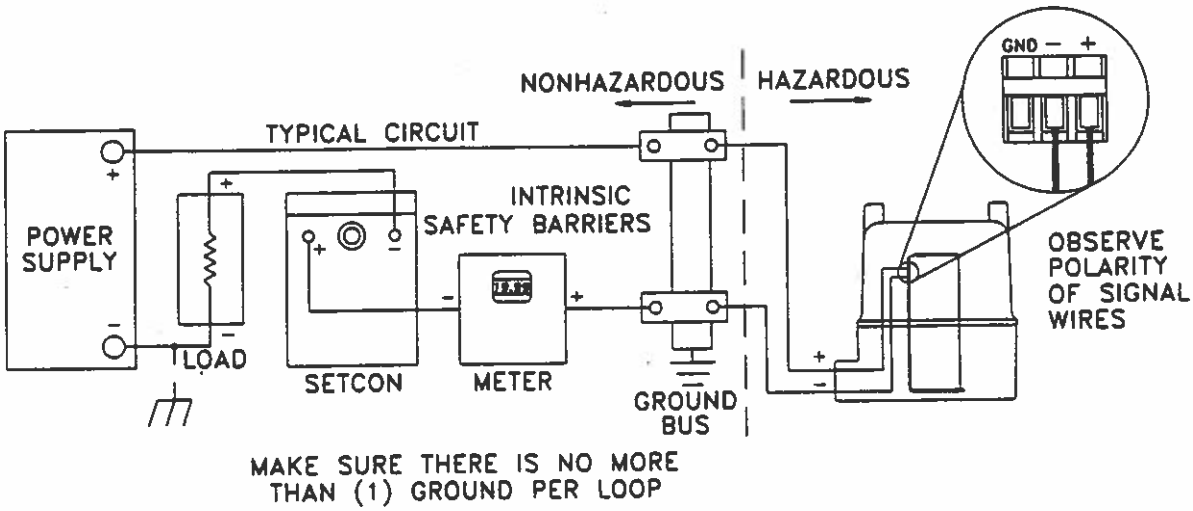


Figure 6-4
Loop Check

6.6 List of Some Possible Problems and Causes

Problem	Possible Cause	Checkout
1. Transmitter reads 20 mA or greater even when vessel is not full.	a. Transmitter malfunction	a. Sec. 6.2.1
	b. Water in probe condulet	b. Sec. 6.4
	c. Short in cable	c. Sec. 6.4
	d. Cut in probe insulation	d. Sec. 6.4
	e. Calibration is wrong	e. Sec. 4.3
2. Transmitter never reaches 20 mA even though the vessel is full, or the output reading is nonlinear at the upper end of the scale.	a. Load resistance too high	a. Sec. 6.2.2
	b. Calibration is wrong	b. Sec. 4.3
	c. Transmitter malfunction	c. Sec. 6.2.1
3. Transmitter is drifting.	a. Moisture in probe gland	a. Sec. 6.3
	b. Water in probe condulet	b. Sec. 6.4
	c. Transmitter malfunction	c. Sec. 6.2.2
	d. Water in cable	d. Sec. 6.4
	e. Cut in probe insulation	e. Sec. 6.4
	f. Calibration is wrong	f. Sec. 4.3
	g. Material properties are changing	g. Consult factory
4. Transmitter is erratic. Output reading jumps anywhere from 0% to 100%.	a. Radio frequency interference	a. Need RFI filters.
	b. Cut in probe insulation	b. Sec. 6.4
	c. Waves in the liquid	c. Sec. 4.1.2
5. Transmitter was shipped precalibrated but is not reading correct level.	a. Wrong precalibration information supplied to factory	a. Verify precal information
	b. Nozzle or pipe around probe is not specified on precalibration sheet	b. Need to include info. on nozzle for precal
	c. Accuracy being checked by measuring outage as a % of full tank	c. Note: The zero point is at end of probe; not bottom of tank
6. Probe installed in stilling well, and readings are incorrect.	a. Probe touching stilling well	a. Adjust mounting
	b. Reading lower than actual level: Air trapped in stilling well	b. Put holes in stilling well to allow air to escape.
	c. Calibration is wrong	c. Sec. 4.3
	d. Material in stilling well may be interfacing	d. Consult factory
	e. If plastic, may cause non-saturation of probe	e. Consult factory
7. As level increases, output reading decreases.	a. Fail-safe in HLFS position	a. Sec. 4.1.3
	b. Transmitter malfunction	b. Sec. 6.2.1
8. Transmitter reading 5% to 10% or greater in error.	a. Conductive buildup on probe	a. Sec. 6.4 Consult Factory
	b. Calibration is wrong	b. Sec. 4.3
9. Erratic or incorrect readings.	a. Ungrounded conducting liquid in a fiberglass vessel	a. Instrument may need a ground. Consult factory.
10. Output current reading less than 3.5 mA	a. Wiring short from shield-to-ground, probably in probe head	a. Sec. 3.5
	b. Probe not connected to transmitter	b. See 3.5 or 3.6

6.7 Factory and Field Service Assistance

6.7.1 Telephone Assistance

If you are having difficulty with your Drexelbrook equipment, and attempts to locate the problem have failed, notify your local Drexelbrook representative, or call toll-free for the service department; 1-800-527-6297. The Fax number is 1-215-674-2731. Drexelbrook Engineering Company is located at 205 Keith Valley Road, Horsham, Pa. 19044. To help us solve your problem quickly, please have as much of the following information as possible when you call:

Instrument Model #408-8200

Probe Model #_____

P.O. #_____
Date of P.O._____

Cable Length _____
Application_____

Material being measured _____
_____
Temperature_____
Pressure _____
Agitation_____
Brief description of the problem _____
_____
_____
_____
Checkout procedures that failed_____
_____
_____

Do not return equipment without first con tacting the factory for a return authorization number. Any equipment being returned must include the following information:

Reason for return_____
_____
Return Authorization #_____
_____
Original P.O. # _____
Drexelbrook order #_____
_____
Your company contact _____
_____
_____
"Ship To" address_____
_____
_____

To keep the paperwork in order, please include a purchase order with returned equipment even though it may be coming back for warranty repair. You will not be charged if covered under warranty. Please return your equipment with freight charges prepaid. We regret that we cannot accept collect shipments.

Drexelbrook usually has a stock of reconditioned exchange units available for faster turnaround of a repair order. If you prefer your own unit repaired rather than ex changed, please mark clearly on the return unit, "DO NOT EXCHANGE".

Spare instruments are generally in factory stock. If the application is critical, a spare chassis should be kept on hand.

6.7.2 Field Service

Trained field service personnel are available on a time-plus-expense basis to assist in start-ups, diagnosing difficult application problems, or in-plant training of personnel.

Periodically, Drexelbrook instrument training seminars for customers are held at the factory. Contact the service department for further details on any of the above.

ASAHI/AMERICA

SERIES 92

Installation, Operation and Maintenance Manual

Description

Asahi/America Series 92 reversing electric actuators feature capacitor run motors and permanently lubricated gear train, with hardened steel spur gears. Standard units can provide up to 1100 in-lbs of output torque.

The Series 92 models feature combination Nema-4, 7 enclosures as a standard and are available in 115VAC, 220VAC, 12VDC, 24VDC, 12VAC, 24VAC voltages.

Standard models are equipped with integral thermal overload protection (AC models) with automatic reset, independently adjustable limit switches and declutchable manual override with position indicating beacon, baked powder epoxy coating with stainless steel trim and ISO bolt circle.

Installation

A. To gain access to terminal strip it is necessary to remove manual override knob (Part #18) by loosening slotted set screw (Part #39). Remove 2 cover screws, the remaining 6 cover screws are packaged inside the actuator.

B. Install conduit fitting (1/2" NPT) to actuator base. Note: Proper conduit fitting must be used to maintain enclosure rating (weatherproof, explosion proof or combination weather proof/explosion proof).

C. Make electrical connections to terminal strip as shown on wiring schematic located inside the cover (per various electrical codes there is a green screw on the actuator base plate for grounding purposes). All units are completely calibrated prior to shipment. No internal adjustments should be required.

D. Replace actuator cover, and gasket if removed. Install 8 cap screws supplied and tighten securely. Unit is now ready for operation.

E. Manual Override Operation

Pull up the declutching knob (Part #18) and apply a 5/8" open end wrench to exposed flats and rotate within labeled limits as indicated by arrows.

To re-engage simply rotate actuator shaft until declutching knob drops back down into position.

Setting Limit Switches

Open Travel Limit Switch (Top Switch Part #25) using declutchable manual override, move the valve into a full open position, loosen set screws on top cam (Part #40) and rotate cam into limit switch arm until a click is heard, this designates the switch circuit has opened and defines a full open position. Tighten 2 set screws (Part #40) on cam.

Closed Limit Switch (Bottom Switch Part #25) using declutchable manual override, move the valve to a full closed position, loosen set screws on bottom cam (Part #40) and rotate cam into limit switch arm until a click is heard, this designates the switch circuit has opened and defines a full closed position. Tighten 2 set screws (Part #40) on cam.

Maintenance

The Series 92 are manufactured with factory lubricated grease, in the gear case and gear box. In most cases, this lubricant should never have to be replenished, however if deemed necessary, we recommend using aeroshell grease #17, mfg by Shell Oil Co.

CAUTION: Before any maintenance is performed and to prevent ignition of hazardous atmospheres, and reduce the chance of electrical shock, NEVER remove actuator cover while circuits are live.

Spare Parts

The following should be kept on hand as spare parts.

1 — Limit Switch (Part #25)

1 — Capacitor (Part #27 or #28)

Please specify model and voltage when ordering.

Electrical Requirements

SIZE	TORQUE	115 VAC		230 VAC		12 VDC		24 VDC		12 VAC		24 VAC		CYCLE TIME 90°	WEIGHT
	IN/LBS	AMP DRAW	DUTY CYCLE	AMP DRAW	DUTY CYCLE	AMP DRAW	DUTY CYCLE	AMP DRAW	DUTY CYCLE	AMP DRAW	DUTY CYCLE	AMP DRAW	DUTY CYCLE	(SEC)	(LBS)
332	400	1.3	75%	.5	75%	2.0	75%	4.0	75%	2.0	75%	1.0	75%	10	10
A32	700	1.3	50%	.5	50%	2.0	75%	4.0	75%	2.0	75%	1.0	75%	10	10
832	1000	1.3	75%	.5	75%	2.0	75%	4.0	75%	2.0	75%	1.0	75%	10	10

Note: All amp ratings are considered locked rotor.

Mounting Instructions

1. Position the valve and the actuator to corresponding positions (either OPEN or CLOSED). The flats on the actuator shaft and the indicator knob should indicate valve position.

2a. Ball Valves: (See Drawing #1263, sizes 1/2"-2")
Install adapter plate #8 to actuator using screws #11. (This step pertains to 1-1/2"-2" 3-way valves only). Mount saddle tight, then tighten set screws #2 to secure in place. Insert coupling #5 on stem of valve and bolt actuator onto assembly tightening bolts #3 evenly.

2b. Ball Valves: (See Drawing #1264, sizes 2-1/2"-4")
Install adapter plate #5 to actuator using screws #7. Mount saddle #4 onto valve; saddle is a tight fit over nick of valve, press down tight, then tighten set screws #2 to secure in place. Insert coupling #6 on stem of valve and bolt actuator onto assembly tightening bolts #3 evenly.

Note: Due to the torque required on sizes 3" and 4", we recommend that saddle #4 be solvent cemented to valve as well as using set screws #7.

2c. Butterfly Valves (up to size 6"): (See Drawing #1265)
A specially machined butterfly valve stem is required to fit with actuator shaft adapter #9. Holes need to be drilled in valve top to accept mounting bracket #2 and bolts #3. Butterfly valve stems are easily removed from manual valves by removing handle or lever and retaining nut. Stem will slide out by pulling upwards on stem. Re-install machined stem and stem retaining nut.

Since butterfly valve disc is trunnion mounted in valve seat, it will not tilt nor tip over if stem is pulled out of valve.

Caution: If valve is in line, do not remove stem until system is shut down and there is no line pressure.

Insert actuator shaft adapter #9 into actuator. Mount bracket #2 to actuator with bolts #7 and tighten evenly. Install valve #1 onto mounting bracket and align stem of valve to engage with actuator shaft adapter. Install bolts and nuts #3 through #6 and tighten evenly. Flats on actuator or indicator shaft should indicate valve position (orientation of disc).

2d. Butterfly Valves (sizes 8" and up):
Same concept and procedure is utilized, however, no machining to any valve part is needed. Remove gear operator from valve. Install mounting bracket to actuator, and install coupling on valve stem. Use same bolt holes where gear operator was previously removed to mount actuator bracket to valve. Again, valve position or disc orientation should be shown by flats on actuator shaft or indicator.

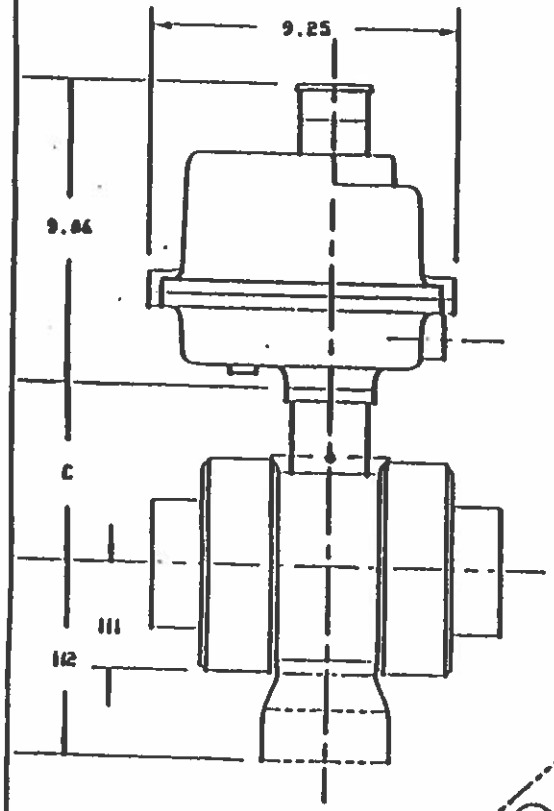
3. Operate the mounted unit to see that the valve and actuator interact smoothly.

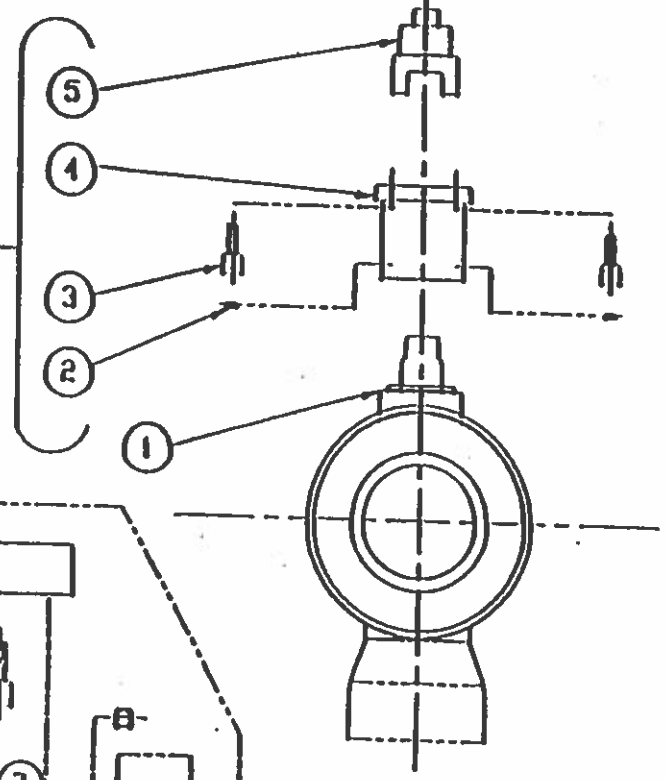
Caution: If mounted unit is installed other than straight up, the actuator should be supported individually in order to prevent sideloading and loosening up of fasteners.

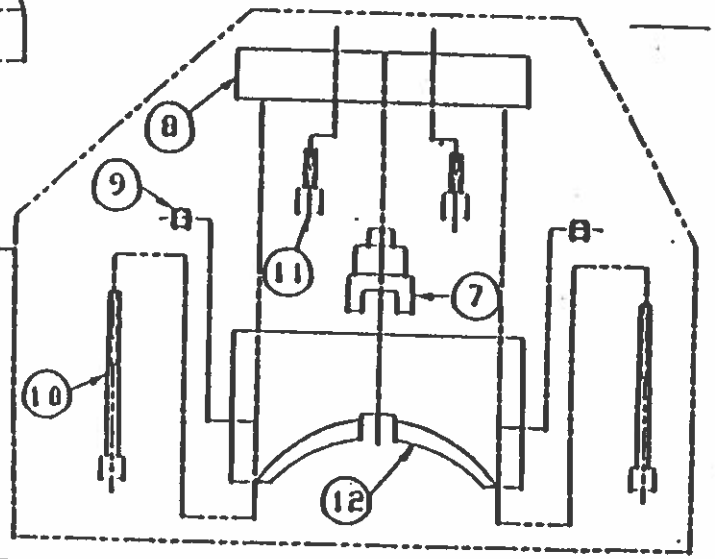
1/2"		1.77	1.95
3/4"		2.17	2.31
1"	1.44	2.60	2.16
1 1/4"	1.57	na	2.92
1 1/2"	1.87	3.06	N:1
2"	2.09	1.45	N:2

1. DIMENSION C FOR 2 WAY 1 1/2 INCH VALVE IS 3.4
   DIMENSION C FOR MULTIPORT 1 1/2 INCH VALVE I ...5
2. DIMENSION C FOR 2 WAY 2 INCH VALVE IS 3.67
   DIMENSION C FOR MULTIPORT 2 INCH VALVE IS 4.00

ITEM	DESCRIPTION	MATERIAL
1	BALL VALVE (2-3 WAY)	
2	SET SCREW	300 SS
3	SCREW SOC HD	300 SS
4	SADDLE	ANODIZED ALUM.
5	ADAPTOR	ANODIZED ALUM.
6	ACTUATOR	ALUM. EPOXY COATED
7	ADAPTOR	ANODIZED ALUM.
8	PLATE MOUNTING	ANODIZED ALUM.
9	SET SCREW	300 SS
10	SCREW SOC HD	300 SS
11	SCREW SOC HD	300 SS
12	SADDLE MOUNTING	PVC







THIS MOUNTING METHOD IS USED FOR 1-1/2 & 2 INCH MULTIPORT VALVES INSTEAD OF USING ITEMS 2-5

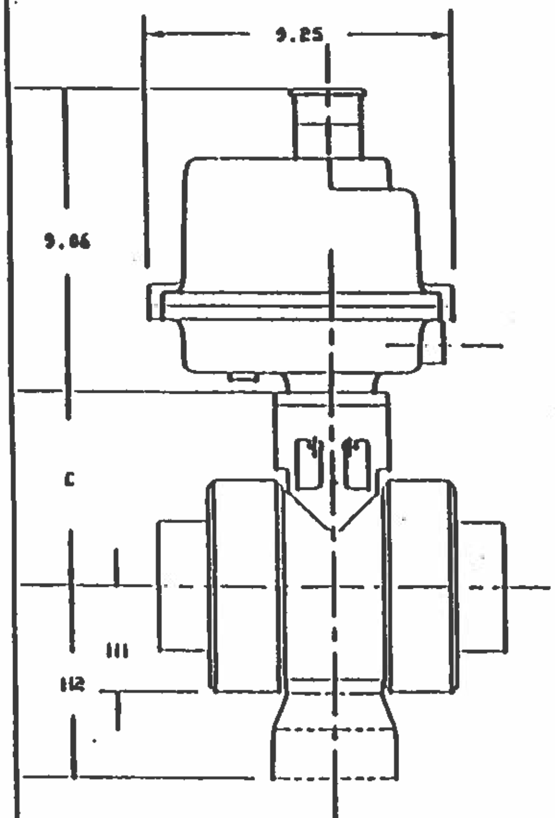
UNLESS OTHERWISE SPECIFIED
SEE PART LIST

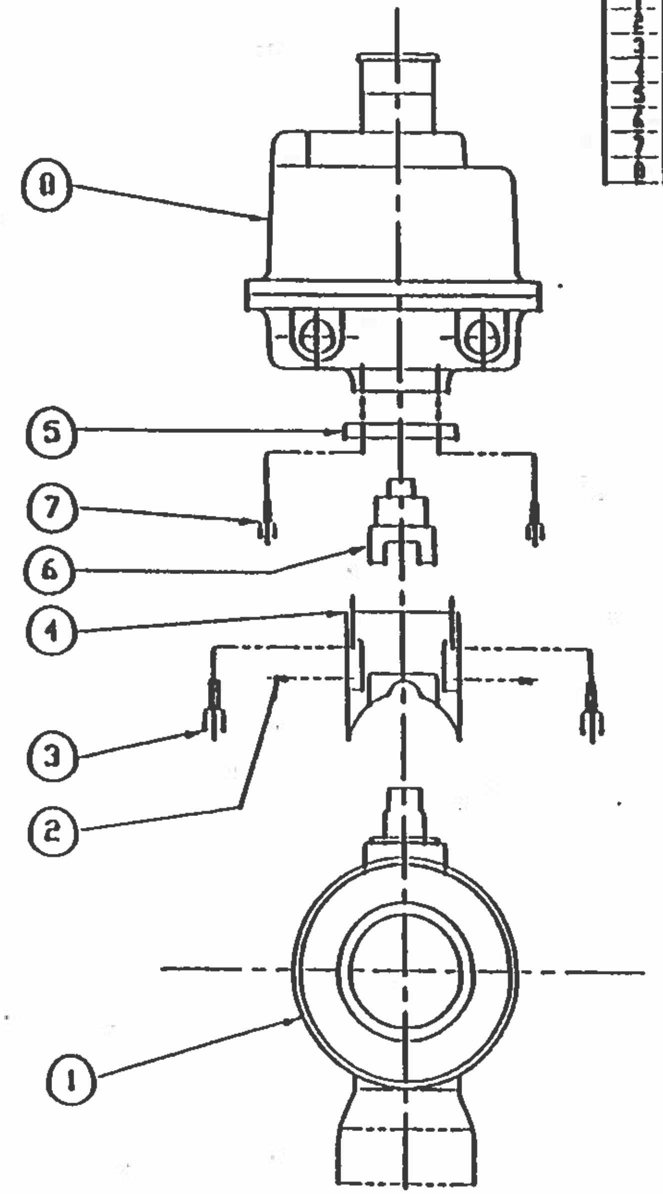
ASAHI/AMERICA

BALL VALVE WITH
SERIES 92 ELECTRIC ACTUATOR

DWG NO. 1263

VALVE SIZE	H1	H2	C
2 1/2"	2.62	-	5.12
3"	2.99	6.14	5.58
4"	4.13	7.62	6.80





ITEM	DESCRIPTION	TRIM
1	BALL VALVE (2-3 WAY)	
2	SET SCREW	300 SS
3	SCREW SOC HD	300 SS
4	SADDLE	PVC
5	PLATE MOUNTING	ANODIZED ALUM.
6	ADAPTER	ANODIZED ALUM.
7	SCREW SOC HD	300 SS
8	ACTUATOR	ALUM.EPOXY COATED

UNLESS OTHERWISE SPECIFIED

MATERIAL: SEE PART LIST

ASAHI/AMERICA

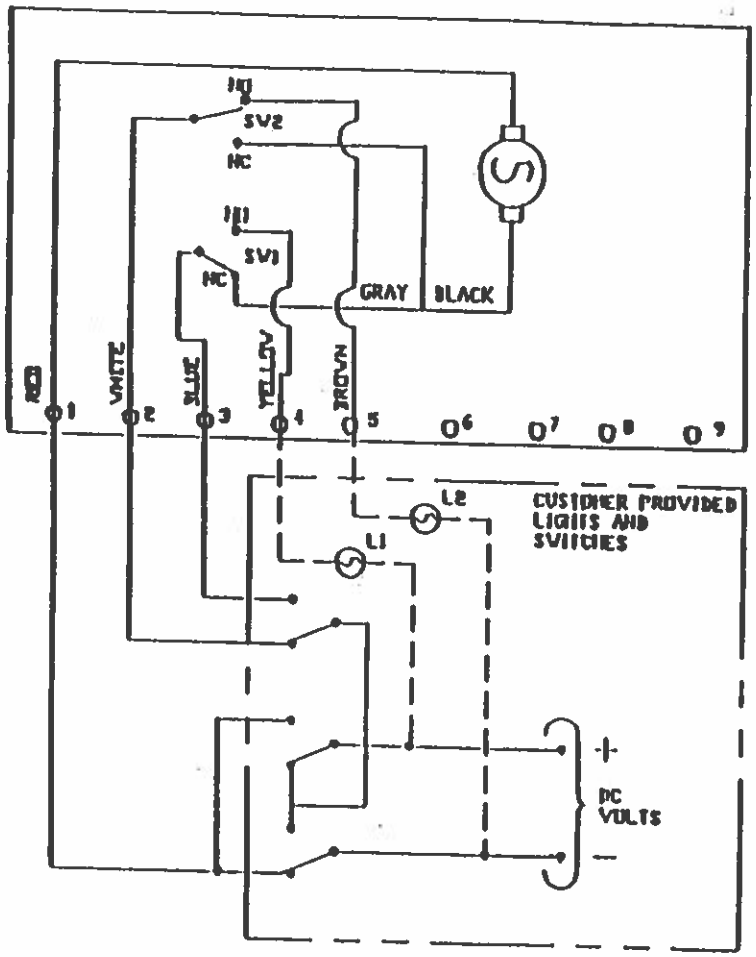
BALL VALVE WITH SERIES 92 ELECTRIC ACTUAT…

DWG. NO. 1264

SCALE NONE

SHEET 1 OF

DC WIRING DIAGRAM



ACTUATOR SHOWN IN COUNTER CLOCKWISE EXTREME OF TRAVEL OR "OPEN" POSITION

1	2	3	
-	+		= OPEN
+		-	= CLOSE

DRAWING TO BE PRINTED ON 3X6 LABEL

	NAME	DATE
DR	MJ	10/12/93
CHK		
APPD		
FILE	S92	

ASAHI/AMERICA

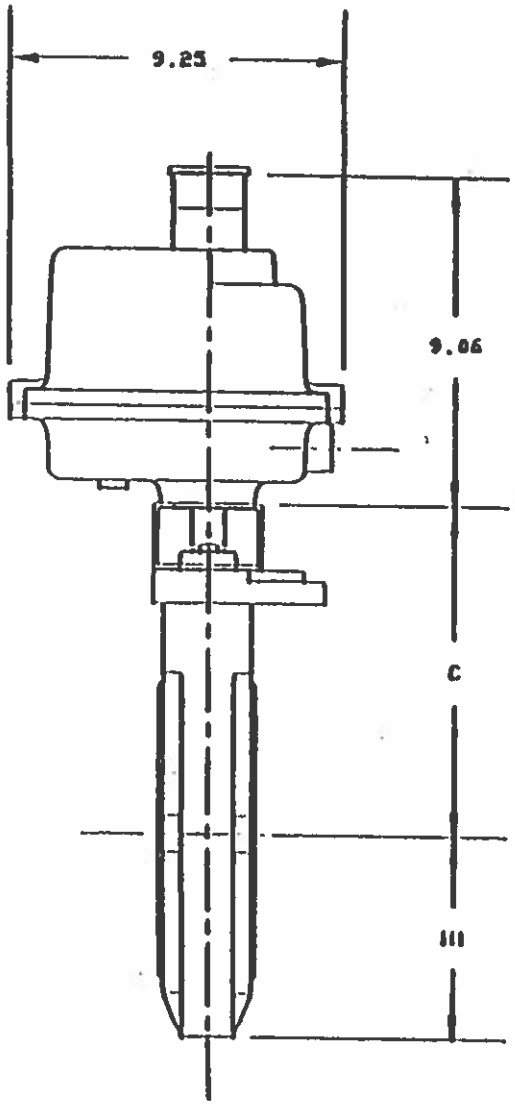
19 GREEN STREET, P.O. BOX 653, MALDEN, MA.

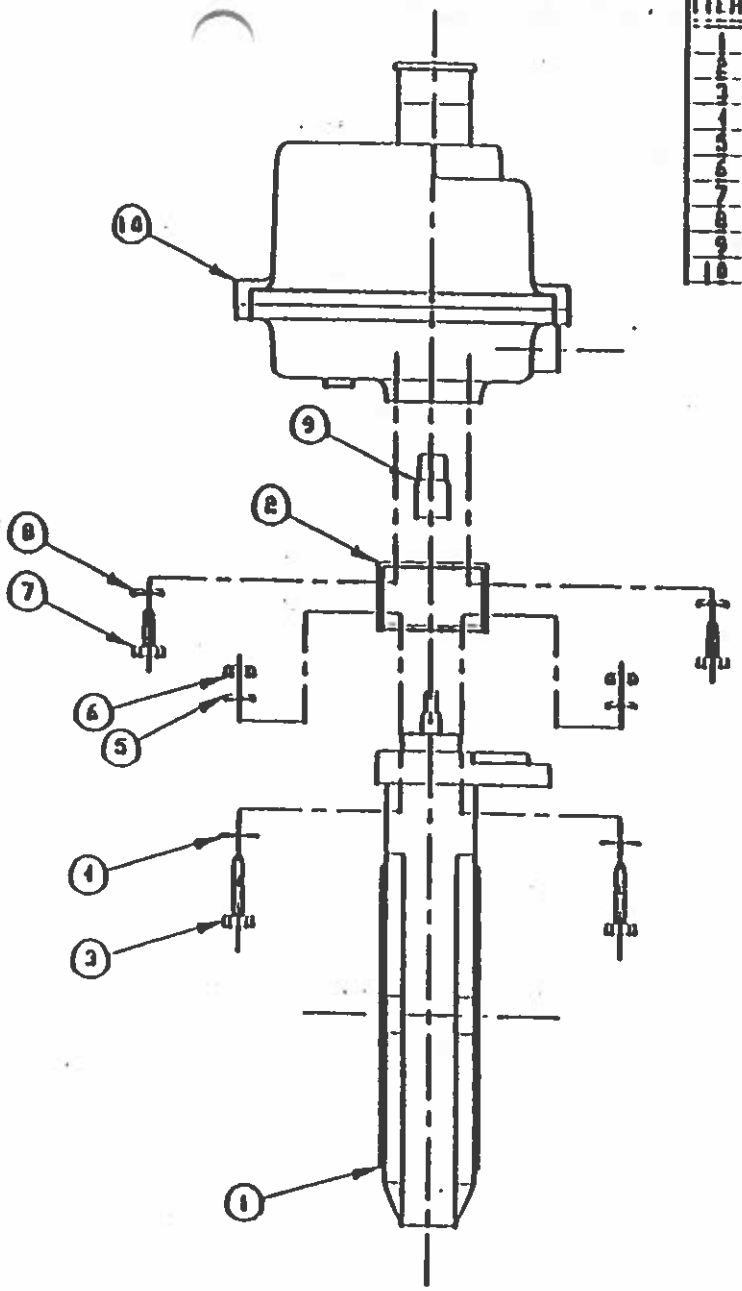
QUARTER MASTER CHIEF DC WIRING DIAGRAM

SIZE	DWG. NO.	REV
A	01792DC	
SCALE NTS	SHEET 1 OF 1	

SIZE	A	C
1 1/2"		5.00
2"		5.00
2 1/2"	3.66	5.50
3"	3.94	5.70
4"	4.53	6.56
5"	5.00	8.05
6"	5.63	8.76
8"	CONSULT FACTORY	

ITEM	DESCRIPTION	MATERIAL
1	BUTTERFLY VALVE	
2	BRACKET MOUNTING	ANODIZED ALUM.
3	SCREW	300 SS
4	WASHER FLAT	300 SS
5	WASHER LOCK	300 SS
6	NUT HEX	300 SS
7	SCREW	300 SS
8	WASHER LOCK	300 SS
9	ADAPTER	ANODIZED ALUM.
10	ACTUATOR	ALUM. EPOXY COATED





UNLESS OTHERWISE SPECIFIED

SEE PART LIST

ASAHI/AMERICA

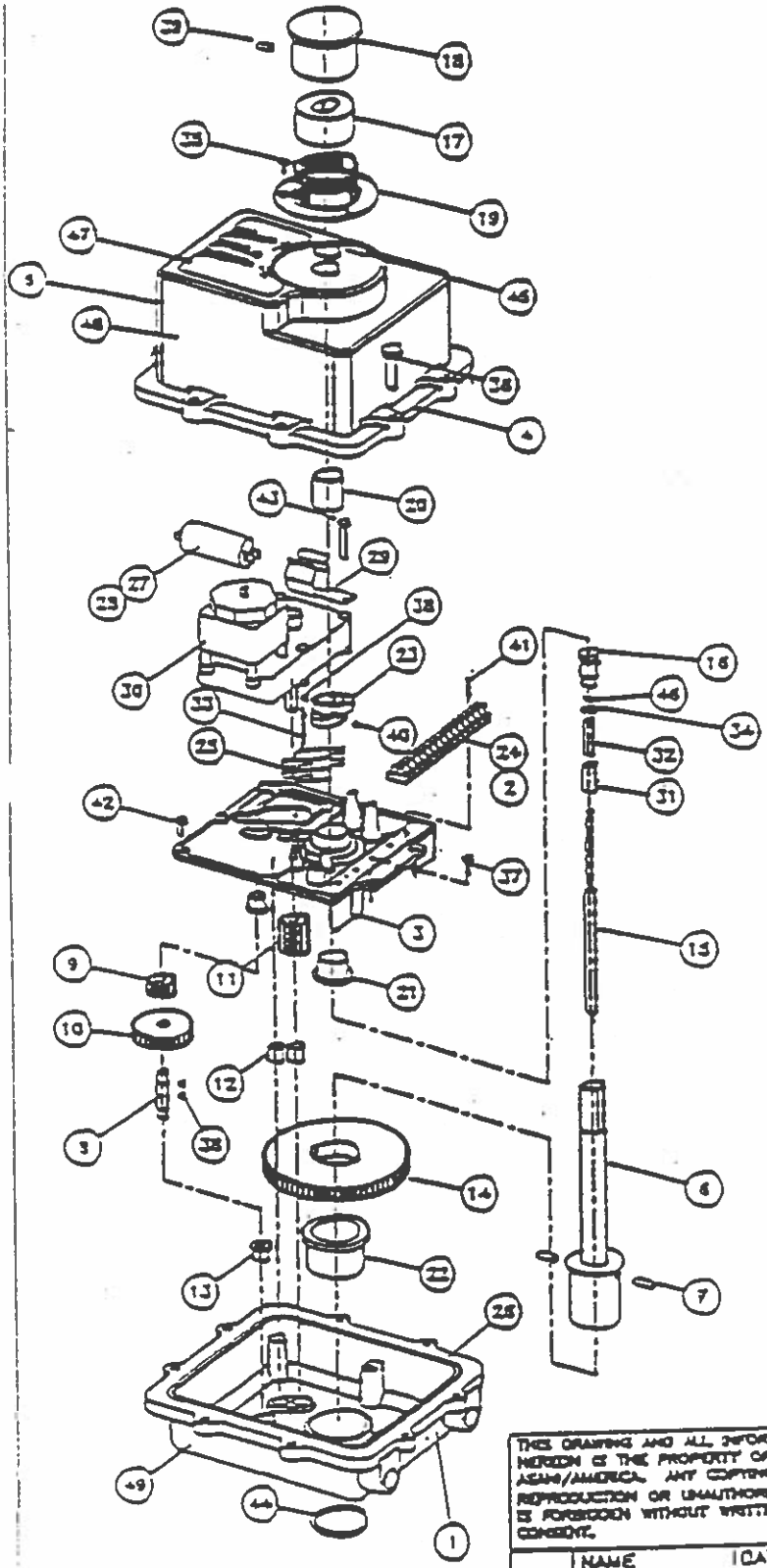
BUTTERFLY VALVE WITH SERIES 92 ELECTRIC ACTUATOR

SIZE 1865

SCALE NONE

SERIES 92

PARTS LIST & MATERIALS OF CONSTRUCTION



ITEM	PART NO	QTY	QTY	DESCRIPTION
1	74011220	1	1	BASE
2	74011440	1	1	WIRING HARNESS
3	74011080	1	1	BASE PLATE
4	74011840	1	1	COVER
5	74011220	1	1	WIRING DIAGRAM LABEL
6	74011900	1	1	SHAFT MAIN
7	74011380	1	1	PIN
8	74011280	-	1	SHAFT STUB
9	74020063	-	1	SPUR GEAR 18
10	74020064	-	1	SPUR GEAR 54
11	74011400	1	1	GEAR PINION
12	74011340	1	1	REVERSE PINION
13	74020056	-	1	REVERSE PL. - SPUR GEAR
14	74011280	1	1	GEAR MAIN
15	74011220	1	1	SHAFT PINION
16	74011120	1	1	SHAFT REDUCER
17	74011300	1	1	CAM LOWER
18	74011320	1	1	CAM UPPER
19	74011280	1	1	COLLAR
20	74011120	1	1	BEARING UPPER [illegible]
21	74011080	1	1	BASE PLATE BEARING
22	74011020	1	1	BASE BEARING
23	74011440	2	2	CAM
24	74011420	2	2	TERMINAL BLOCK
25	74011440	2	2	SWITCH ACTUATOR
26	74011340	1	1	O-RING BASE/COVER
27	74020004	-	1	CAPACITOR 4.7 mfd
28	74011940	1	-	CAPACITOR 12 mfd
29	74011320	1	1	CLAMP CAPACITOR
30	74011340	1	1	MOTOR
31	74011220	1	1	SHELL
32	74011220	1	1	SPRING
33	74011020	2	2	SCREW ROUND HD. #6-32 X 1.00 LG
34	74011240	2	2	WASHER, FLAT #10 .440ID X .045THK
35	74011080	3	3	SCREW FLAT HD. #6-32 X .38 LG. SS
36	74011640	6	6	SCREW HEX HD. 5/16-18 X 1.0 SS
37	74011520	1	1	SCREW SELF TAP (GREEN) #10X .5LG
38	74011880	1	1	KEY, WOODRUFF 3/32
39	74011700	1	1	SCREW SLOT SET #6-32 X .3 LG SS
40	74011740	4	4	SCREW SET #6-32 X .12 LG
41	74011600	4	4	SCREW SELF TAP #4X .5LG
42	74011680	3	3	SCREW SELF TAP SLOT/HEX #10X .5LG
43	74011720	4	4	SCREW SLOT/HEX 10-32 X 1.62 LG
44	74011040	1	1	SEAL BASE
45	74011140	1	1	SEAL COVER
46	74011580	1	1	O-RING SHAFT
47	74011820	1	1	OVERRIDE LABEL
48	74011940	1	1	COVER NAMEPLATE
49	74011970	1	1	BASE NAMEPLATE

	NAME	DATE
DR	IT CASTLES	4/92
CHK		
APPD		

FILE \ACAD11\S92\ASAHI92

DO NOT SCALE DRAWING

ASAHI/AMERICA

19 GREEN STREET, P.O. BOX 811, MALDEN, MA.

SERIES 92 EXPLODED VIEW

SIZE A | DWG. NO. | REV

SCALE NTS | SHEET 1 OF 1

EMERSON-CHROMALOX

Installation Instructions

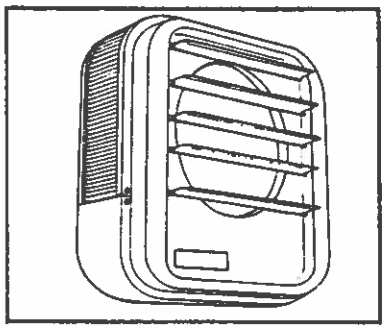
and

RENEWAL PARTS IDENTIFICATION

SERVICE REFERENCE		
DIV.	SEC.	NUMBER
SALES REFERENCE		MUH400E
		5200 0722 002
DATE	May, 1980	

MODULAR UNIT HEATERS

CATALOG NUMBERS▲ LISTED BELOW

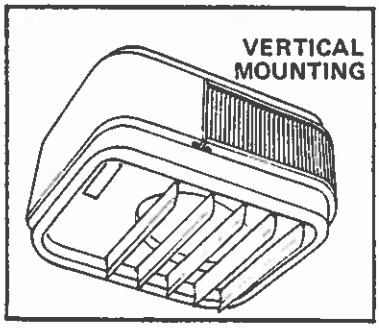


HORIZONTAL MOUNTING

▲Suffix "M" added after the basic Catalog Number indicates that the Unit Heater is "made-to-order".

** Available with line voltage contactor
Cat. No. MUH-05-2-MG
Cat. No. MUH-05-8-MG

† Available with built-in thermostat;
Cat. No. MUH-05-2-T.



VERTICAL MOUNTING

Table 1. Specifications

Basic Cat. No.	Voltage (V)	Wattage (KW)	Phase (ϕ)	Amperage	B.T.U.	Height	Width	Depth	Mounting Weight (lbs.)
MUH-03-8	208	3	1	14.5	10,236	16	14	7½	27
MUH-03-2	208/240	2.2/3	1	10.8/12.5	7506/10,236				27
MUH-03-7	277	3	1	11	10,236				27
MUH-03-4	480	3	3	3.7					30
MUH-05-8	208	5	1-3	24*	17,060				27
**† MUH-05-2	208/240	3.7/5	1-3	18.1/21*	12,795/17,060				27
MUH-05-7	277	5	1	18	17,060				27
MUH-05-4	480	5	3	6					30
MUH-07-8	208	7.5	1-3	36*	25,590	21¾	19	7½	38
MUH-07-2	208/240	5.6/7.5	1-3	27.4/31*	19,106/25,590				38
MUH-07-7	277	7.5	1	27.	25,590				38
MUH-07-4	480	7.5	3	9					38
MUH-10-8	208	10	1-3	48*	34,120				38
MUH-10-2	208/240	7.5/10	1-3	36.1/42*	25,590/34,120				38
MUH-10-7	277	10	1	36	34,120				38
MUH-10-4	480	10	3	12.1					38
MUH-15-8	208	15	1-3	72*	51,180	21¾	19	12¾	54
MUH-15-2	208/240	11.2/15	3	31.4/36.2	38,214/51,180				50
MUH-15-4	480	15	3	18.1	51,180				50
MUH-20-8	208	20	3	56	68,460				60
MUH-20-2	208/240	15/20	3	42/48.2	51,180/68,460				55
MUH-20-4	480	20	3	24.1	68,460				55
MUH-25-2	208/240	18.7/25	3	52.4/60	61,804/85,825	30	26 5/8	11¾	89
MUH-25-4	480	25	3	30.2	85,825				89
MUH-30-8	208	30	3	84	102,390				89
MUH-30-2	208/240	22.5/30	3	63/72.3	76,770/102,390				89
MUH-30-4	480	30	3	36.2	102,390				89
MUH-40-2	208/240	30/40	3	84/96.4	102,390/136,520	30	26 5/8	17 1/8	119
MUH-40-4	480	40	3	48.1	136,520				119
MUH-50-8	208	50	3	139	170,600				119
MUH-50-2	208/240	37.5/50	3	105/120.5	127,950/170,600				119
MUH-50-4	480	50	3	60.3	170,600				119

*NOTE: Amperage shown is single phase; to obtain three-phase amperage, divide value by 1.73

IMPORTANT! !

FAILURE TO UNDERSTAND AND FOLLOW THESE INSTALLATION INSTRUCTIONS AND THE "CAUTION" NOTES THEREIN MAY RESULT IN SERIOUS PERSONAL INJURY FROM ELECTRICAL SHOCK, OR FROM THE HEATER FALLING DUE TO FAULTY MOUNTING INSTALLATION.

CAUTION

TO AVOID POSSIBLE ELECTRICAL SHOCK, BE SURE ELECTRICITY IS TURNED OFF AT MAIN SWITCH FIRST BEFORE WIRING. ALL WIRING MUST BE IN ACCORDANCE WITH LOCAL ELECTRICAL CODES AND THE HEATER MUST BE GROUNDED AS A PRECAUTION AGAINST POSSIBLE ELECTRICAL SHOCK.

DO NOT MOUNT MERCURY TYPE THERMOSTAT DIRECTLY ON UNIT. VIBRATION COULD CAUSE HEATER TO MALFUNCTION.

THE HEATER MUST BE MOUNTED AT LEAST 7' ABOVE THE FLOOR TO PREVENT ACCIDENTAL CONTACT WITH THE FAN BLADE WHICH COULD CAUSE INJURY.

THE CEILING MOUNTING STRUCTURE AND THE ANCHORING PROVISIONS MUST BE OF SUFFICIENT STRENGTH TO SUPPORT THE COMBINED WEIGHT OF THE HEATER AND MOUNTING BRACKET. (REFER TO TABLE 1 FOR WEIGHTS OF HEATER AND BRACKET.)

CAUTION—ALL BUILT-IN THERMOSTATS:

IF THE HEATER IS USED TO PREVENT PIPING OR LIQUIDS FROM FREEZING, AND IF THE THERMOSTAT IS SET BELOW 45° F., THE FAN MUST BE RUN CONTINUOUSLY.

SINGLE POLE THERMOSTATS (Available as a kit or factory installed option). Turn the knob clockwise to raise the temperature setting. The lowest temperature setting is 40° F., (full counterclockwise rotation).

TWO-STAGE THERMOSTAT (Available as a kit or factory installed option). Turn the knob clockwise to raise the temperature setting. The lowest temperature setting is 40° F., (full counterclockwise rotation). This thermostat has two live operating contacts. **Two-pole thermostats have only one live operating contact and a hazardous condition may exist if used in place of a two-stage thermostat.**

HEAT RECOVERY THERMOSTAT (Available as a kit or factory installed option). Turn the knob clockwise to raise the temperature for the fan turn on. Full counterclockwise rotation of the knob is approximately 60° F. Full clockwise rotation at the knob is approximately 120° F. The mid-point at the rotation should be approximately 90° F.

POWER DISCONNECT SWITCH (Available as a kit or factory installed option). This switch disconnects the power to the power terminal block when the handle is turned to its full counterclockwise position. The power is on when the switch handle is rotated clockwise. If for any reason the knob is removed, it should be aligned with the "OFF" mark when the switch is off (Full counterclockwise rotation).

1. Use copper conductor supply wire only when connecting to the power line. (See Figure 11.)
2. Connection to the switch pigtails should be made with compression connectors and the joint should be then well insulated.
3. Consult the local wiring code in your area.

SUMMER FAN SWITCH (MOUNTED ON BACK OF HEATER). When the switch handle is pointing toward the "FAN ON" position, the fan will run continuously. When the switch handle is pointing toward the "AUTO" position the fan will run only when the heating elements are hot.

REMOTE FAN SWITCH (MANUAL SWITCH-LINE VOLTAGE). The wall switch is packed in the wiring compartment. The remote fan switch is mounted external and remote from the MUH unit heater. The voltage of the remote fan switch is the same as the supply voltage to the MUH heater.

1. Use 14 gage copper, NEC Class 1, 600V rated insulated wire. Wiring must meet all Local and NEC requirements for 480-volt service.
2. Install the remote fan switch in standard wall box in any convenient location that is protected from traffic or other accidental damage.
3. Connect the 14 gage copper field wire to the switch lead wires with suitable connectors.
4. A ½-inch knockout is provided in the back of the heater adjacent to the control terminal board. Use a crimp-on terminal suitable for a No. 8 screw on the control terminal board. Connect one field wire terminated lead to terminal F1 and the other terminated lead to terminal F2. Refer to Figure 10 for connecting to heaters without built-in contactors. Refer to Figure 9 for connecting to heaters equipped with built-in contactors.

REMOTE FAN SWITCH (USED WITH 24-VOLT RELAY) (Available as a kit or factory installed option). The wall switch is packed in the wiring compartment.

1. Use 18 gage (min.) NEC Class 1 600V wiring that meets all Local and NEC requirements.
2. Install the wall switch in a standard wall box in any convenient location that is protected from traffic or other accidental damage.
3. Connect the field wire to the switch lead wires with suitable connectors.
4. A ½-inch knockout is provided in the back of the heater adjacent to the control terminal board. Use a crimp-on terminal suitable for a No. 8 screw on the control terminal board. Connect one field wire terminated lead to terminal "R" and the other terminated field wire lead to terminal "G". Refer to Figure 9.

MANUAL RESET LIMIT (Factory installed option only). The limit switch is located internally on the rear of the heater. On the MUH-03 and MUH-05 models, the access to the reset button is on the right side (when facing rear of heater); on all other models it is near the top rear of the heater.

The manual reset limit is in series with the automatic recycling protector (limit). The manual reset limit will not reset until the button is pushed in.

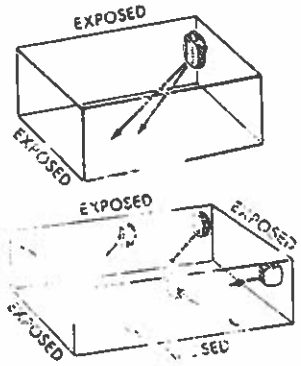
HEATER LOCATION INSTRUCTIONS

Arrange units so their discharge air streams:

a. are subjected to a minimum of interference from columns, machinery and partitions:
b. wipe exposed walls without blowing directly at them;
c. are directed away from room occupants in comfort heating;
d. are directed along the windward side when installed in a building exposed to a prevailing wind.

Locate thermostats on interior partition walls or posts away from cold drafts, internal heat sources and away from heater discharge air streams.

Small rooms can be heated by one unit heater. Where two walls are exposed, the heater should be mounted like this. [illegible] rooms require multi-unit [illegible] and capaci[illegible] mined by [illegible] and square feet [illegible] be heated. Arrange [illegible] provide perimeter air [illegible] tion where each unit discharges the air stream from another.



MOUNTING THE HEA[illegible]

CAUTION

TO PREVENT AN UNSAFE CONDITION, KEEP AT LEAST 5' CLEARANCE IN FRONT OF HEATER. REFER TO TABLE 2 FOR SIDE, TOP, AND BACK CLEARANCE REQUIREMENTS.

GENERAL

The heater may be mounted to discharge the heated air either horizontally or vertically. When the heater is mounted for vertical discharge, it is recommended that the heater be positioned so that the access door will open away from the wall to provide the greatest access to the wiring and control compartment. If the heater is to be mounted with the access door facing a wall, the heater must be mounted far enough from that wall to allow full opening of the access door (a distance approximately equal to the width of the heater . . . check clearance before installing). Refer to Table 2 and Figure 1 for wall and ceiling clearances before mounting the heater.

The heater may be mounted for either vertical or horizontal discharge by the use of threaded rods. (Refer to Table 3 for threaded rod sizes required.) Observe the detailed procedures in the following installation instructions.

The heater may also be suspended from the wall or ceiling by means of an optional mounting bracket (type MMB) which permits horizontal pivoting of the heater. The mounting brackets consist of two main components: the unit mounting bracket; and the wall-ceiling bracket. A pivot bolt with nut and washers are also included. Installation procedures for these mounting brackets are contained in Mechanical Accessories Installation Instructions, sales reference MUH 402.

After the heater is installed, the louvers may be positioned to direct the heated air in the desired direction. When the heater is installed for horizontal discharge, the louvers should direct the air either straight ahead or downward. Directing the air upward may cause the heated air to remain in the ceiling area and waste energy.

HORIZONTAL DISCHARGE (Rod-Mount from Ceiling)

1. Remove four bolts from the threaded holes in flanges at the top of the heater.

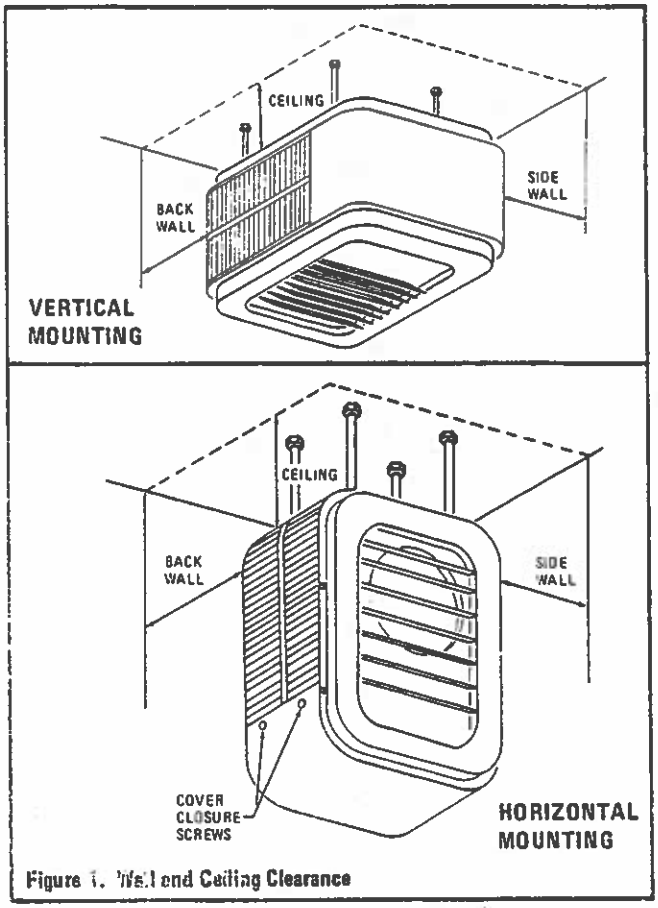


Figure 1. Wall and Ceiling Clearance

Table 2. Wall and Ceiling Clearance (Inches)

Unit	Discharge	Ceiling	Side Wall	Back Wall
3 & 5 KW	Horiz.	2	6	9-1/2
	Vert.	6	18	18
7.5-10 KW	Horiz.	6	6	13
	Vert.	6	24	24
15-20 KW	Horiz.	6	9	13
	Vert.	6	24	24
25-50 KW	Horiz.	16	12	19
	Vert.	12	36	36

2. Install four threaded mounting rods in the threaded holes and secure in place using lock nuts as shown in Figure 2. (Refer to Table 3 for mounting rod thread size).
3. Securely attach the four mounting rods to the ceiling. (Refer to Table 2 for wall and ceiling clearances, and Figure 3 for mounting spacing dimensions.)

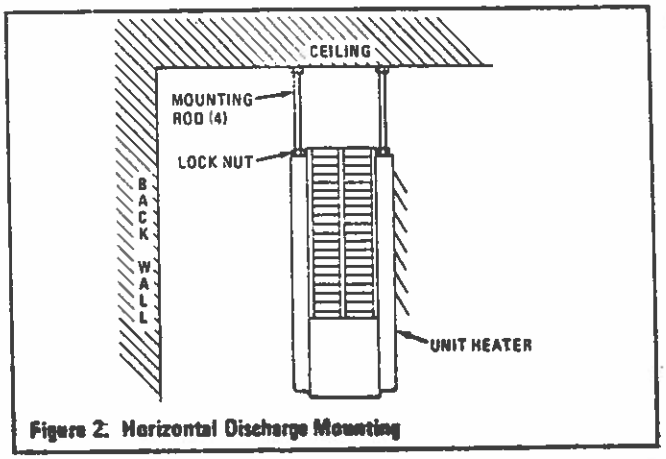
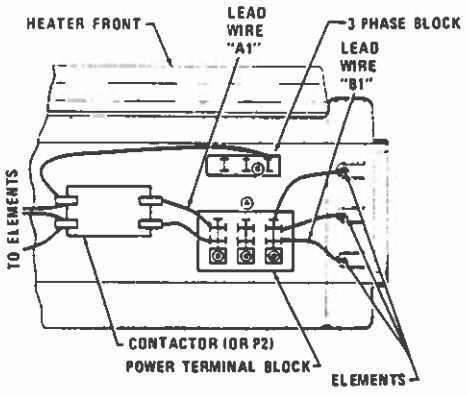


Figure 2. Horizontal Discharge Mounting

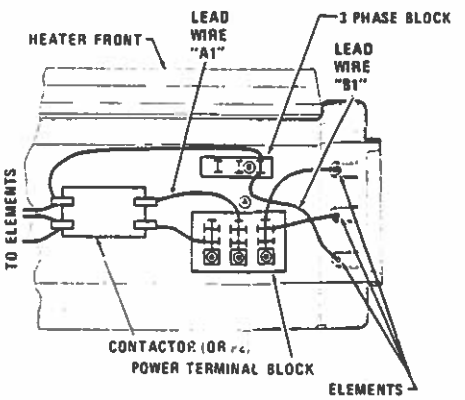
these two three-phase terminal blocks. Do not move or change any other wires. Move the wires marked "C1" and "D1" to terminal "B" on the three-phase terminal block.

9. Electrical Accessories, either kits or factory-installed options, are shown connected by a dash line on the heater wiring diagram.

10. **208/240 VOLT HEATER.** Interchange transformer red and black primary leads (see wiring diagram) when the heater is to be connected to 208 volt supply.

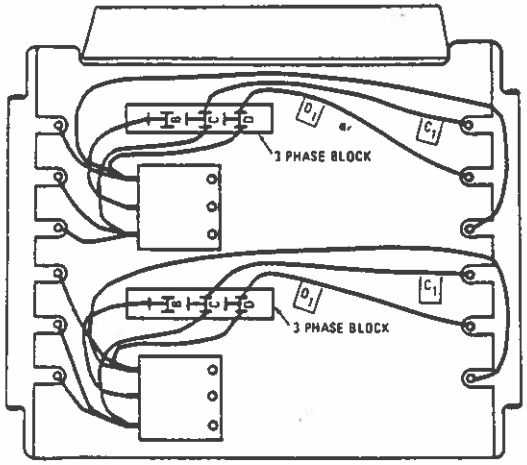


FACTORY-WIRED FOR SINGLE PHASE POWER

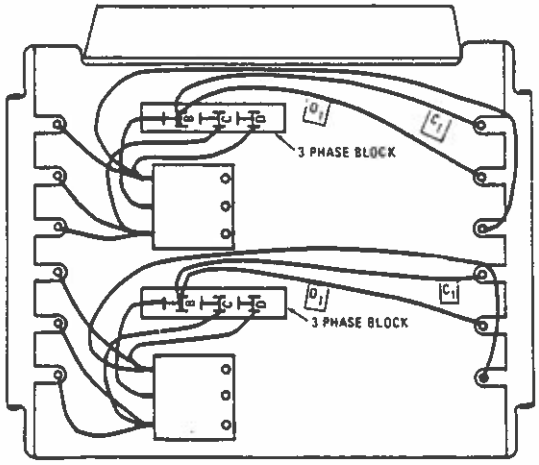


FIELD-WIRED FOR THREE-PHASE POWER

Figure 6a. Wiring Connections for Single-Phase and Three-Phase Power (MUH-05-2, MUH-05-8, MUH-07-2, MUH-07-8, MUH-10-2 and MUH-10-8)



FACTORY-WIRED FOR SINGLE PHASE POWER



FIELD-WIRED FOR THREE PHASE POWER

Figure 6b. Wiring Connections for Single-Phase and Three-Phase Power (MUH-15-8)

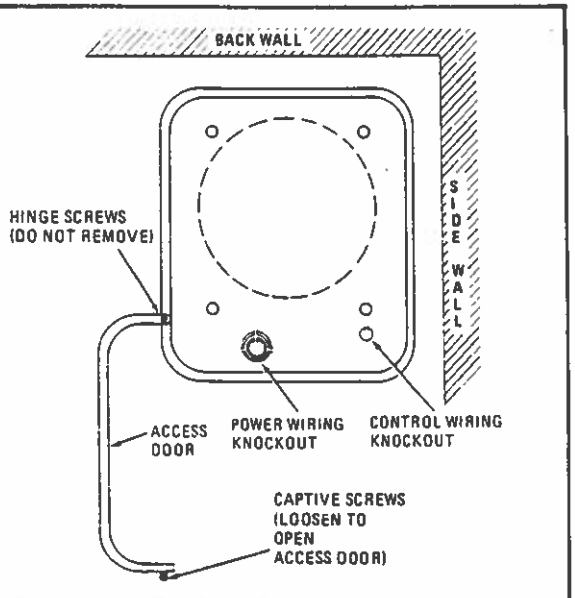


Figure 7. Knockout Location

CONTROL VOLTAGE WIRING – EXTERNAL THERMOSTATS AND FAN SWITCHES (Refer to Figure 8 for Wiring Diagrams)

CAUTION

LINE VOLTAGE IS PRESENT ON SOME OF THE TERMINALS ON THE CONTROL TERMINAL BOARD. ALWAYS DISCONNECT THE POWER FROM THE HEATER BEFORE MAKING ANY CONNECTIONS TO THE CONTROL TERMINAL BOARD.

1. Use 600 volt, NEC Class 1 insulated wiring with a minimum gage of 18 for thermostats and a minimum gage of 14 for line voltage motor switch (remote fan switch without relay).
2. Use a crimp-on type fork terminal on the wire end that attaches to the MUH control terminal board IF more than one connection is to be made under the terminal screw.
3. The thermostat should be located in the area to be heated on an inside wall. The thermostat should not be exposed to drafts, sunlight, radiation from hot objects, or in a direct line with the discharge from the unit heater.
4. Install the thermostat approximately 5 feet above the floor line.

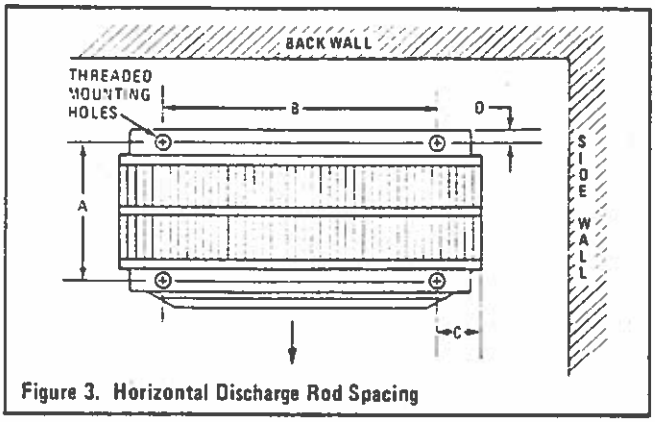


Figure 3. Horizontal Discharge Rod Spacing

Table 3. Rod Thread Type and Spacing Dimensions (inches) for Horizontal Discharge

Unit	Rod Thread Type	A	B	C	D
3-5 KW	5/16-18	6-1/16	6	4-1/16	3/4
7.5-10 KW			8-7/8	5-1/8	3/4
15-20 KW		11-3/8			
25-30 KW	3/8-16	10-9/16	14-1/2	6-3/16	5/8
40-50 KW		15-15/16	14-1/2	6-3/16	5/8

VERTICAL DISCHARGE (Rod-Mount from Ceiling)

1. Remove four bolts (if present) from the threaded holes in the back of the heater.
2. Install four threaded mounting rods in the threaded holes and secure in place using lock nuts as shown in Figure 4. (Refer to Table 3 for mounting rod thread size).
3. Securely attach the four mounting rods to the ceiling. (Refer to Table 2 for wall and ceiling clearances, and Figure 5 for mounting rod spacing dimensions.)

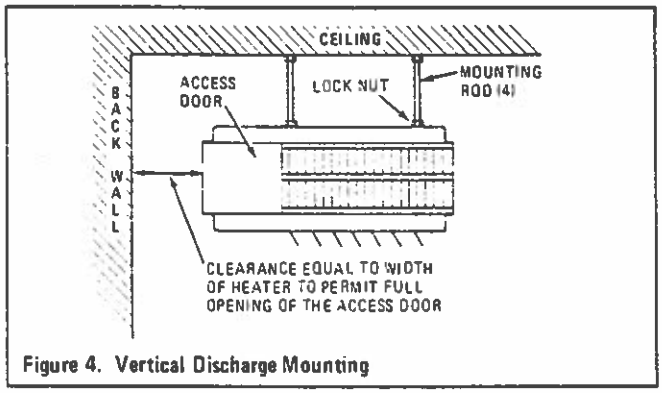


Figure 4. Vertical Discharge Mounting

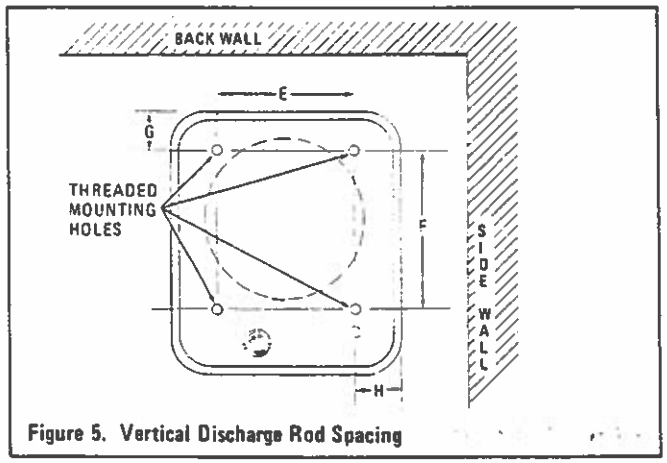


Figure 5. Vertical Discharge Rod Spacing

Table 4. Rod Thread Type and Spacing Dimensions (inches) for Vertical Discharge

Unit	Rod Thread Type	E	F	G	H
3-5 KW	5/16-18	6	9-3/4	2	4-1/16
7.5-20 KW		8-7/8	14-5/8	2	5-1/8
25-50 KW	3/8-16	14-1/2	21-1/4	2-3/16	6-3/16

WIRING

CAUTION

TO AVOID POSSIBLE ELECTRICAL SHOCK, BE SURE ELECTRICITY IS TURNED OFF AT MAIN SWITCH FIRST BEFORE WIRING. ALL WIRING MUST BE IN ACCORDANCE WITH LOCAL ELECTRICAL CODES AND THE HEATER MUST BE GROUNDED AS A PRECAUTION AGAINST POSSIBLE ELECTRICAL SHOCK.

BRANCH CIRCUIT (POWER)

1. CONNECT HEATER ONLY TO THE VOLTAGE AND FREQUENCY SPECIFIED ON THE NAMEPLATE.
2. ALL WIRING TO BE DONE IN ACCORDANCE WITH LOCAL AND NATIONAL ELECTRICAL CODES.
3. The access door is hinged. There are either one or two screws, accessible from the side, that must be loosened to gain access (Figure 7). These screws are the captive type; do not try to remove them.
4. A knockout (Figure 7) is provided in the back of the heater close to the power terminal block and the control terminal board. The control terminal board knockout is 1/2-inch conduit size. The power terminal block knockout is multiple diameter. Use the diameter that fits the required conduit size.
5. A ground terminal is provided near the power terminal board. The ground wire should be connected before other connections are made.
6. The power terminal board is equipped with box terminals sized to accept the correct size power supply wire. Wire rated at 600 V and 60°C. is satisfactory for the heater branch circuit. Either aluminum or copper wire is satisfactory for connection to the heater power terminal board box terminals. Copper wire is recommended.
7. Each heater has a wiring diagram fixed to the inside of the access door. Consult this diagram before making any field connections.
8. Single or three-phase power connections may be used with heater models MUH-05-2, MUH-05-8, MUH-07-2, MUH-07-8, MUH-10-2, MUH-10-8, and MUH-15-8. These heaters are factory-wired for single-phase power. To convert these heaters for use with three-phase power, reconnect the wires as indicated in the wiring diagram attached to the heater. Additional information can be found by looking at the wiring illustrations in Figures 6a and 6b.

   On models MUH-05-2, MUH-05-8, MUH-07-2, MUH-07-8, MUH-10-2, and MUH-10-8 (Figure 6a), move only the two wires marked "A1" and "B1"; do not move or change any other wiring. The element lead wire marked "B1", which is factory connected to the power terminal block (terminal located closest to the elements) must be moved to terminal "B" on the three-phase terminal block. The relay (contactor) lead wire "A1" must be moved from the end terminal of the power terminal block (terminal closest to the contactor or control terminal board) to the "A" terminal of the lower terminal block (center terminal).

   Model MUH-15-8 (Figure 6b) has two three-phase terminal blocks located adjacent to the relays (contactors). Move only the two wires marked "C1" and "D1" on each of

5. Install the remote fan switch in any convenient location that is protected from traffic or likely accidential damage.

6. Internal optional controls are shown on the unit heater wiring diagrams by a dash line.

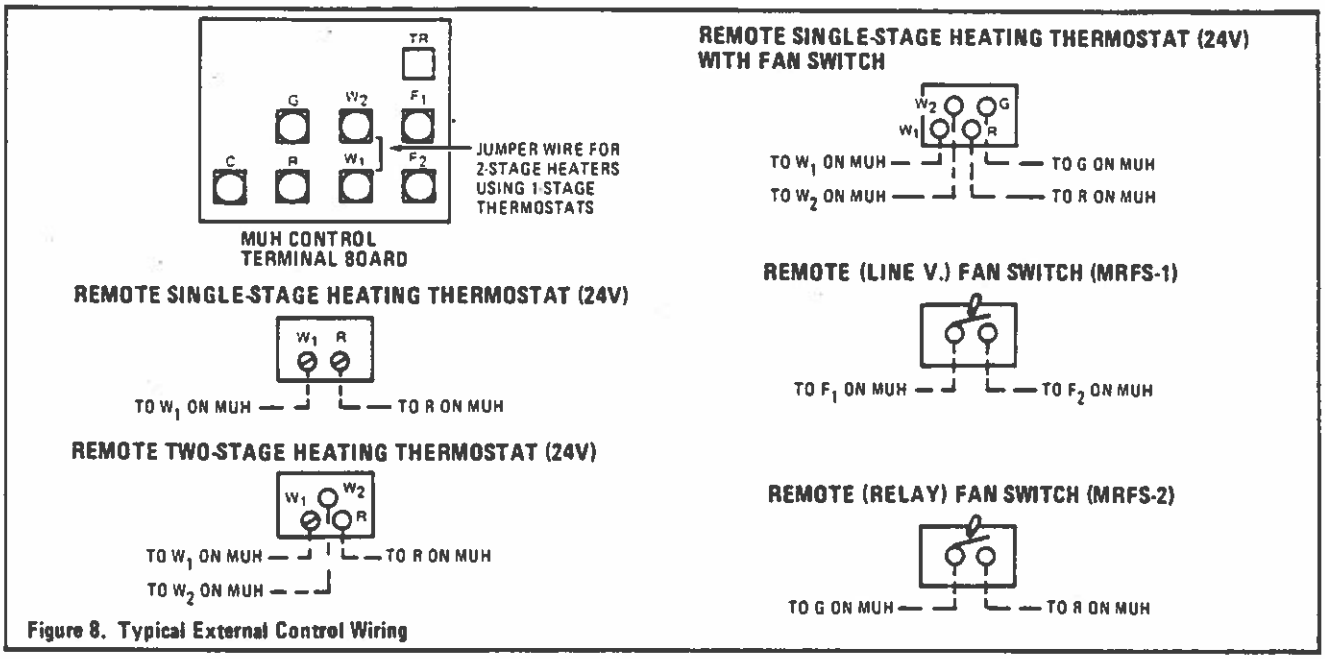


Figure 8. Typical External Control Wiring

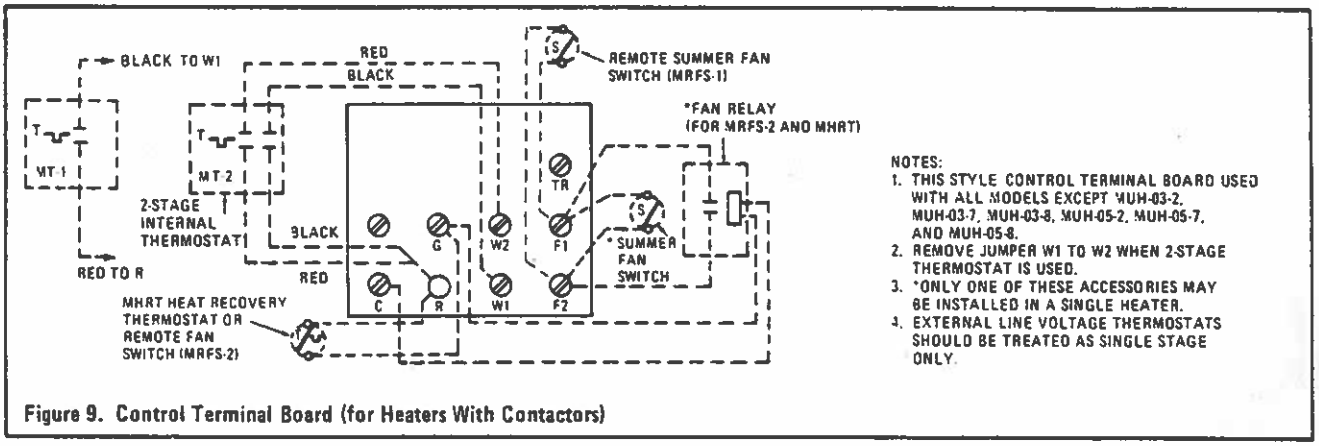


Figure 9. Control Terminal Board (for Heaters With Contactors)

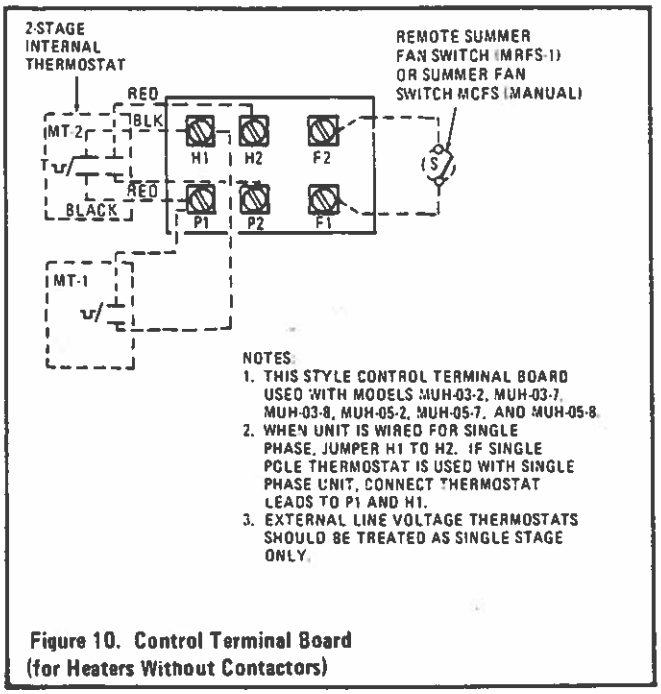


Figure 10. Control Terminal Board (for Heaters Without Contactors)

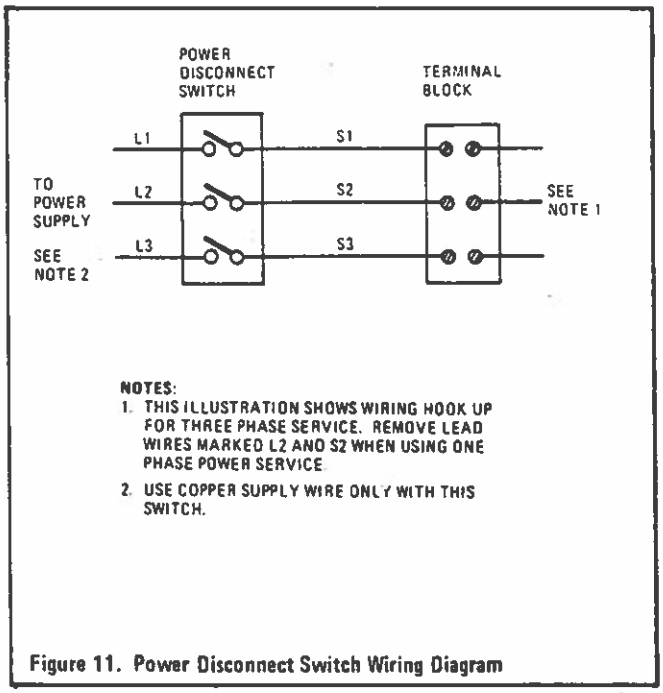
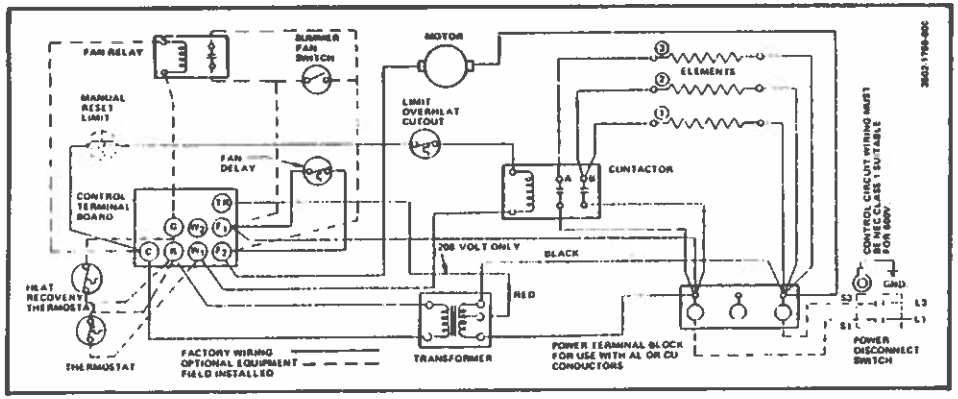


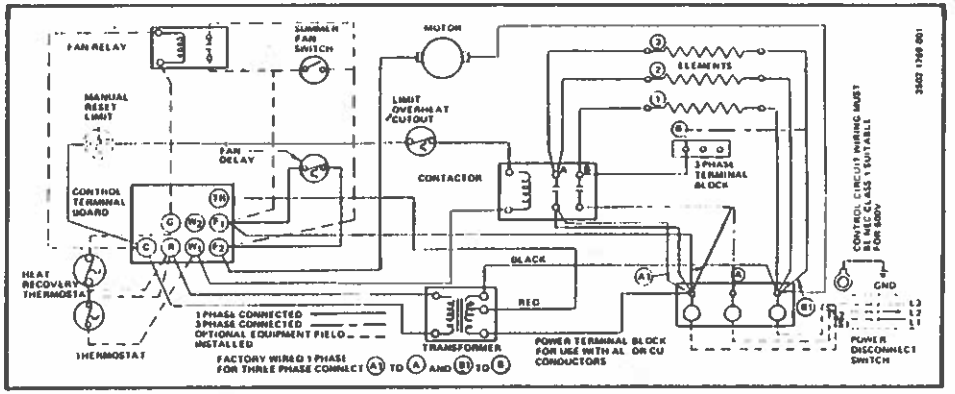
Figure 11. Power Disconnect Switch Wiring Diagram

WIRING DIAGRAMS*

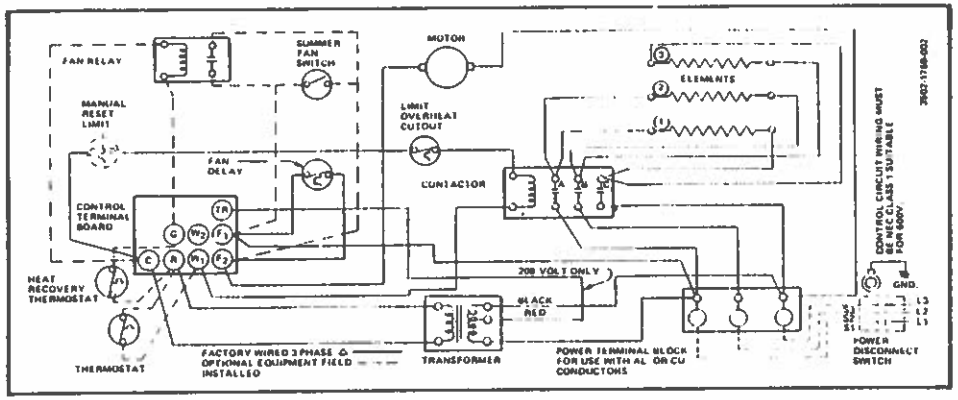
*NOTE: The highest number element ted at the rear of the heater housing.



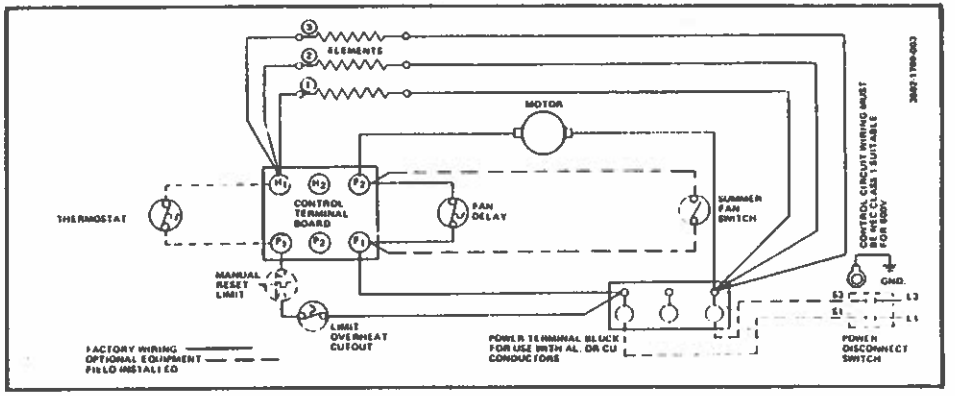
3 ELEMENT, SINGLE PHASE (Models MUH-07-7 and MUH-10-7)



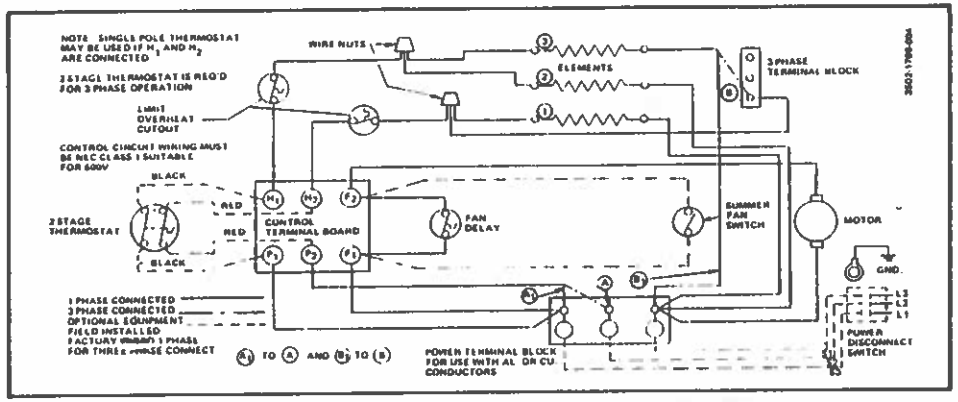
3 ELEMENT, SINGLE AND THREE PHASE (Models MUH-07-2 and MUH-10-2)



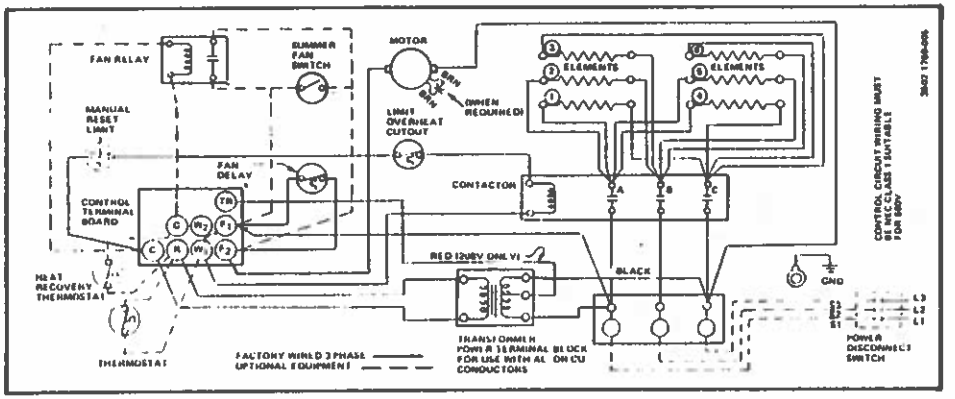
3 ELEMENT, THREE PHASE (Models MUH-03-4, MUH-05-4, MUH-07-4 and MUH-10-4)



3 ELEMENT, SINGLE PHASE (Models MUH-03-2, MUH-03-7, MUH-03-8 and MUH-05-7)



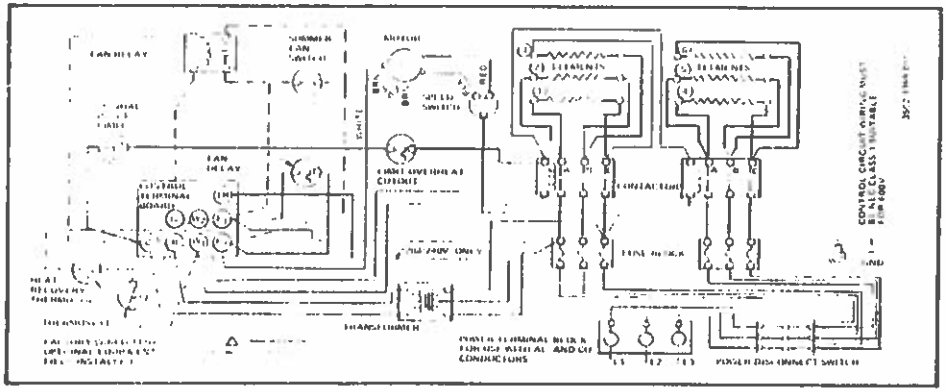
3 ELEMENT, SINGLE AND THREE PHASE (Models MUH-05-2 and MUH-05-8)



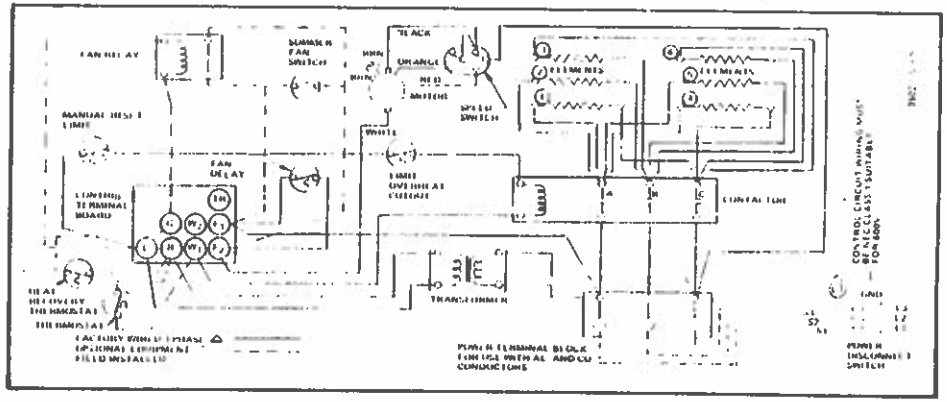
6 ELEMENT, THREE PHASE (Models MUH-15-2, MUH-15-4, MUH-20-2 and MUH-20-4)

WIRING DIAGRAMS*

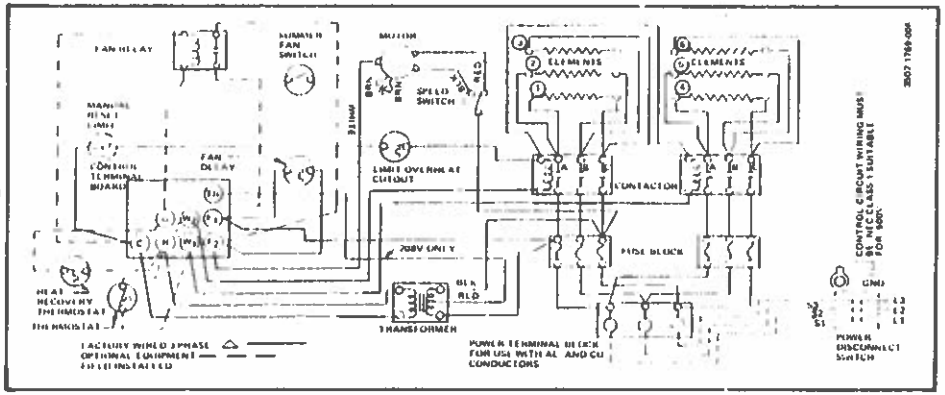
*NOTE: The highest number element is located at the rear of the heater housing.



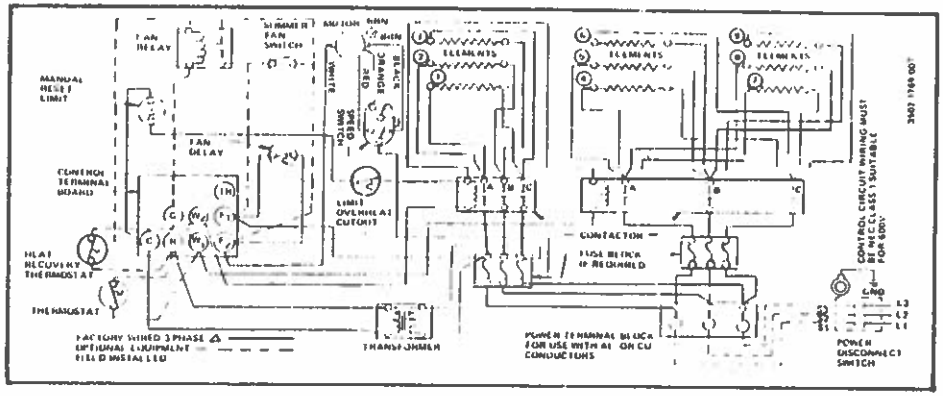
6 ELEMENT, 2 CONTACTOR, 3 PHASE



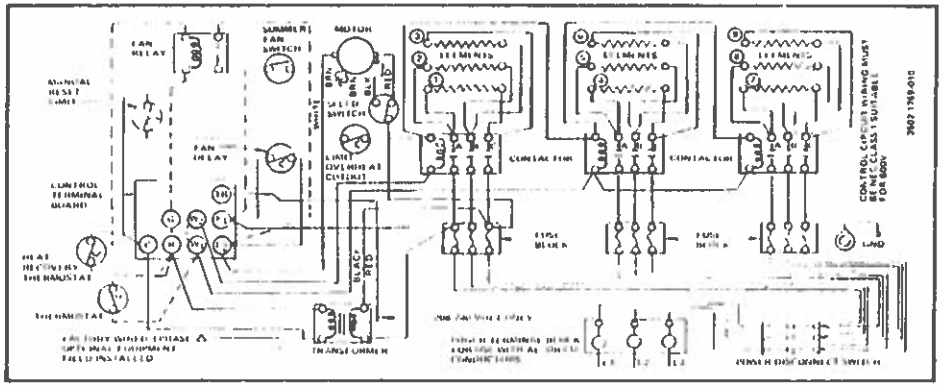
6 ELEMENT, 3 PHASE (Models MUH-25-4 and MUH-30-4)



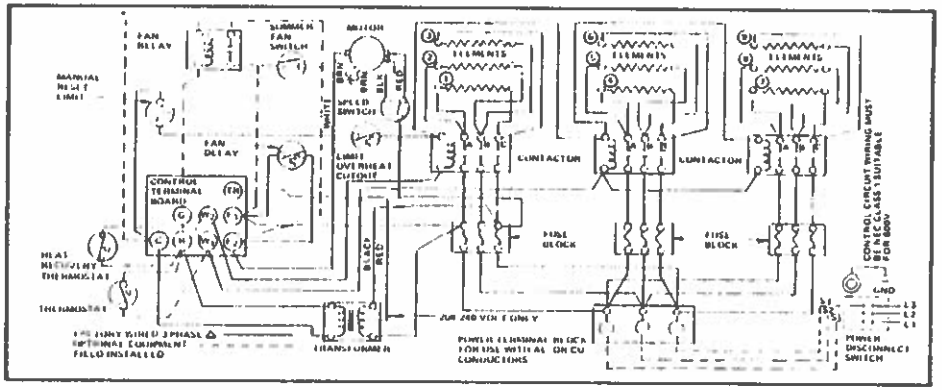
6 ELEMENT, 2 CONTACTOR, 3 PHASE (Models MUH-25-2 and MUH-30-2)



9 ELEMENT, 2 CONTACTOR, 3 PHASE (Models MUH-40-4 and MUH-50-4)



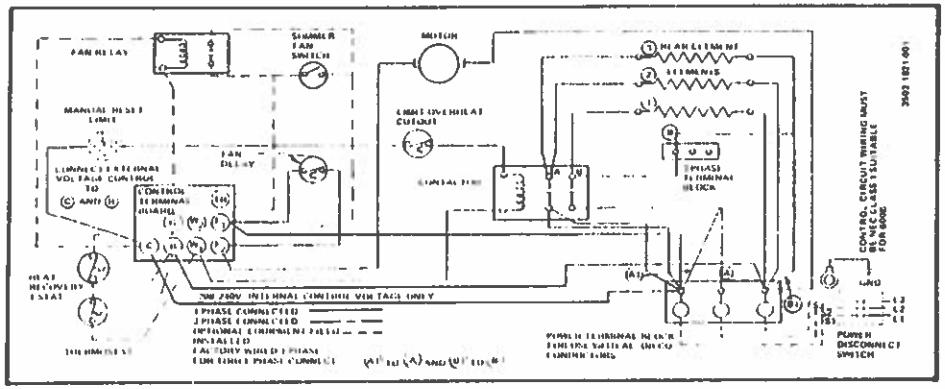
9 ELEMENT, 3 CONTACTOR, 3 PHASE



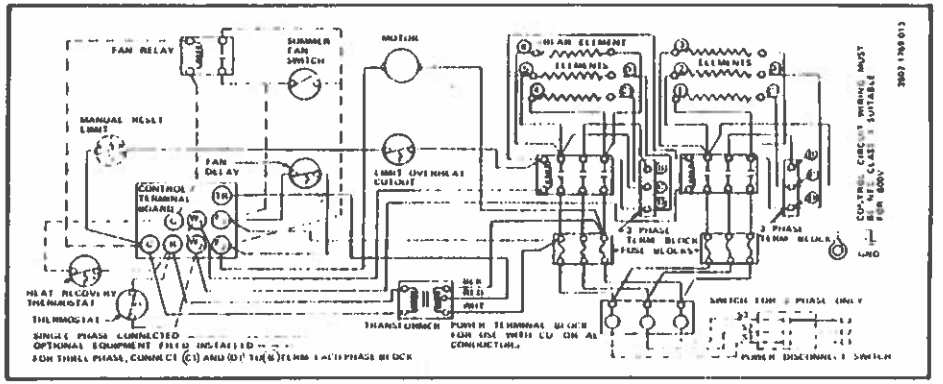
9 ELEMENT, 3 CONTACTOR, 3 PHASE (Models MUH-40-2 and MUH-50-2)

WIRING DIAGRAMS *

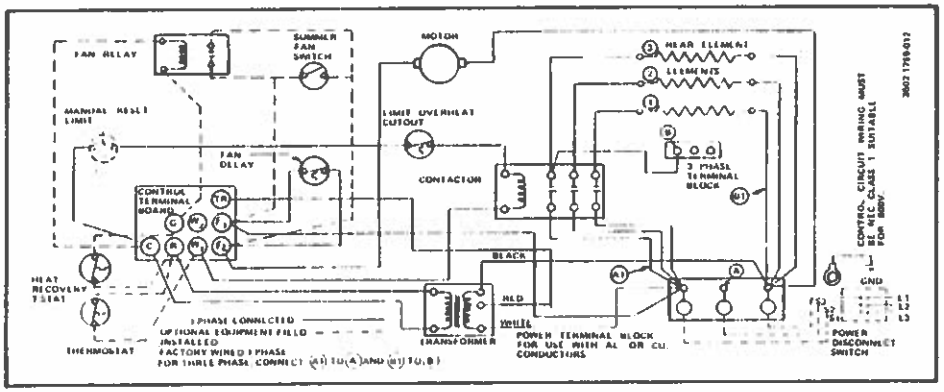
*NOTE: The highest number element is located at the rear of the heater housing.



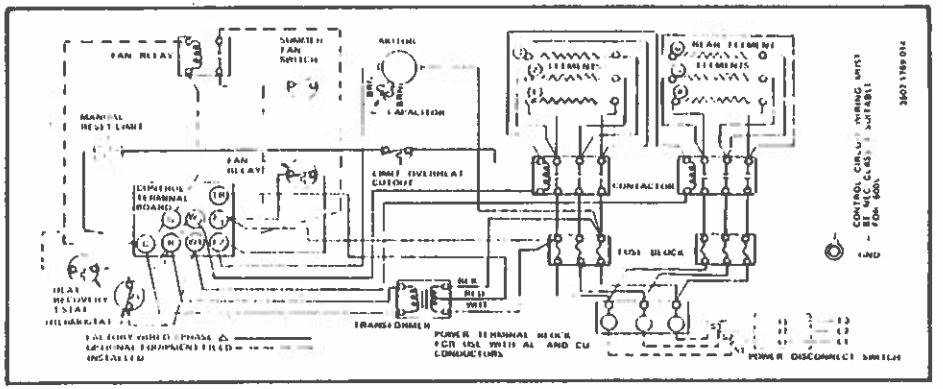
3 ELEMENT SINGLE AND THREE PHASE (Models MUH-05-2-MG and MUH-05-8-MG)



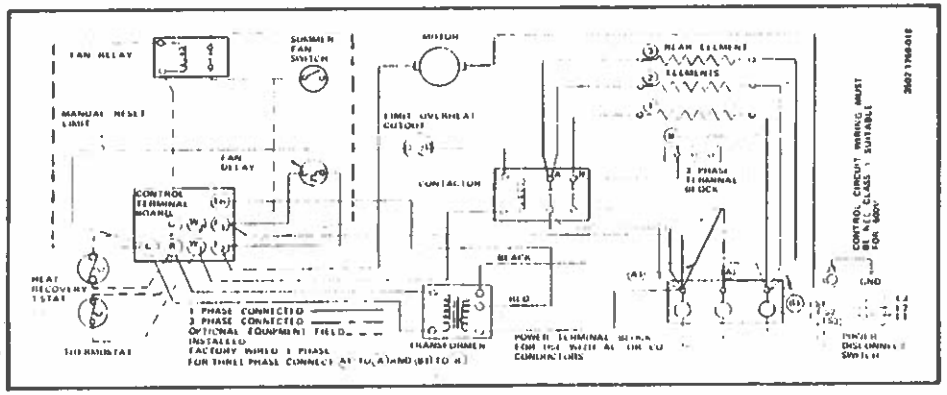
6 ELEMENT 2 CONTACTOR SINGLE AND THREE PHASE (Model MUH-15-8)



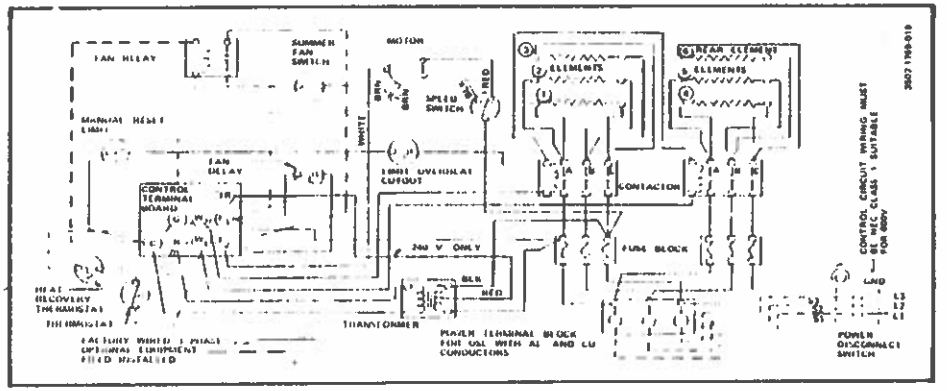
3 ELEMENT SINGLE AND THREE PHASE (Model MUH-10-8)



6 ELEMENT 2 CONTACTOR THREE PHASE (Model MUH-20-8)



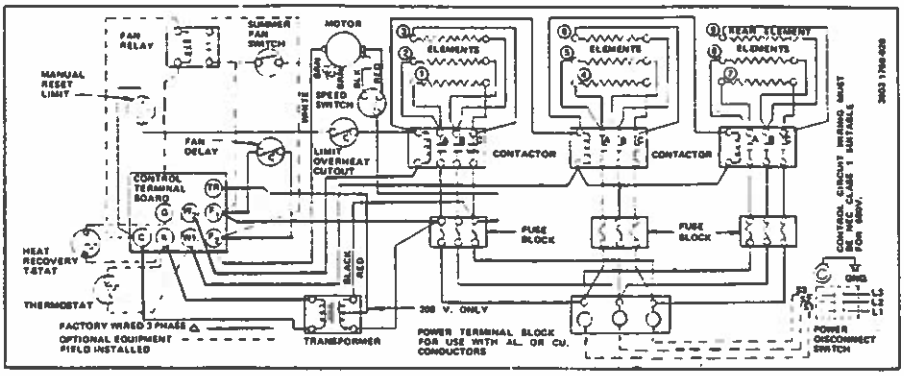
3 ELEMENT SINGLE AND THREE PHASE (Model MUH-07-8)



6 ELEMENT 2 CONTACTOR THREE PHASE (Model MUH-30-8)

WIRING DIAGRAMS*

*NOTE: The highest number element is located at the rear of the heater housing.



9 ELEMENT 3 CONTACTOR THREE PHASE (Model MUH-50-8)

MANUFACTURER PART NUMBER BREAKDOWN FOR MADE-TO-ORDER UNITS LOCATED ON UNIT NAMEPLATE *

MUH-A □□□□□□□□□□□□□

Code Nos.	Heater Wattage
01	2.2
02	3.0
03	3.7
04	5.0
05	5.6
06	7.5
07	10.0
08	11.2
09	15.0
10	18.7
11	20.0
12	22.5
13	25.0
14	30.0
15	37.5
16	40.0
17	50.0

Code Nos.	Manual Reset Limit
00	No Manual Reset Limit
39	Manual Reset Limit

Code Nos.	Disconnect Switch
00	No Disconnect Switch
79	Disconnect Switch

Code Nos.	Fan Switch
00	No Fan Switch
66	Summer Fan Switch
67	Remote Fan Switch (Relay)
68	Heat Recovery Thermostat
69	Remote Fan Switch (Manual)
70	Heat Recovery Thermostat and Remote Fan Switch Relay

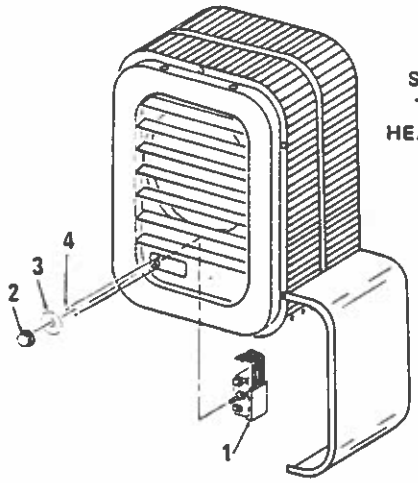
Code Nos.	Heater Voltage
27	208V, 1 or 3Ø
28	240V, 1 or 3Ø
29	277V, 1Ø
30	480V, 3Ø

Code Nos.	Thermostat
00	No Thermostat
55	1-Stage Thermostat
56	2-Stage Thermostat

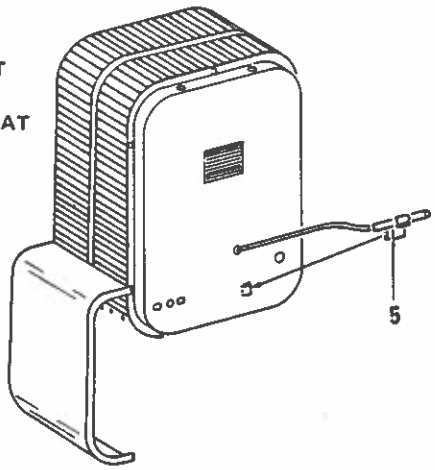
Code Nos.	Contactor Control Voltage
40	No Contactors
41	24 Volts Internal
42	120 Volts Internal
43	208/240 Volts Internal
44	24 Volts External
45	120 Volts External

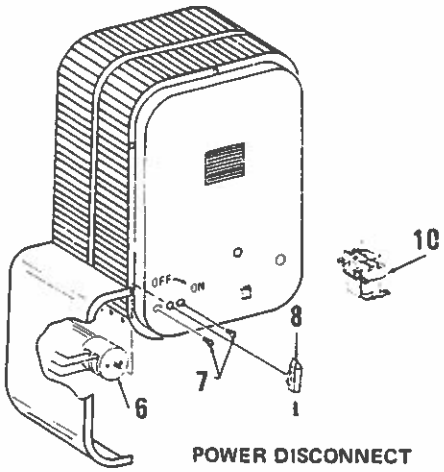
*NOTE: Made-to-Order Heaters have a Suffix "M" as part of the Catalog Number. (i.e. MUH-10-4-M)

RENEWAL PARTS IDENTIFICATION
(FOR BUILT-IN CONTROLS—MADE-TO-ORDER UNITS ONLY)

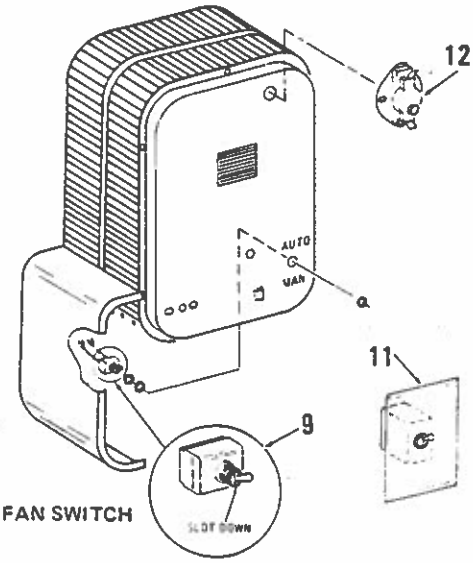


SINGLE-POLE THERMOSTAT
TWO-STAGE THERMOSTAT
HEAT RECOVERY THERMOSTAT





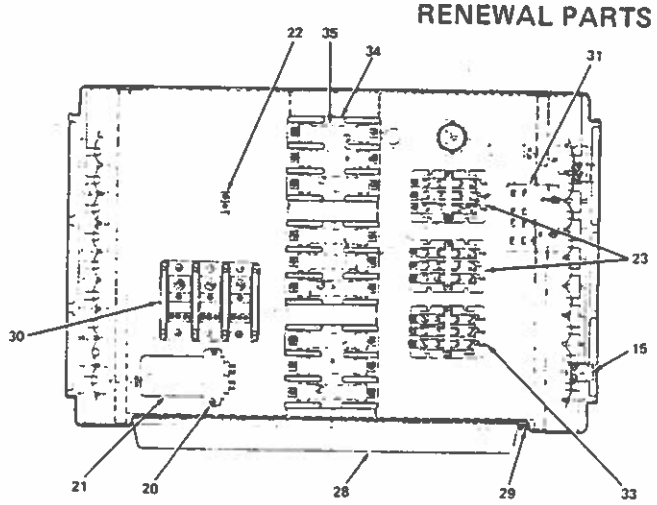
POWER DISCONNECT
SWITCH



SUMMER FAN SWITCH

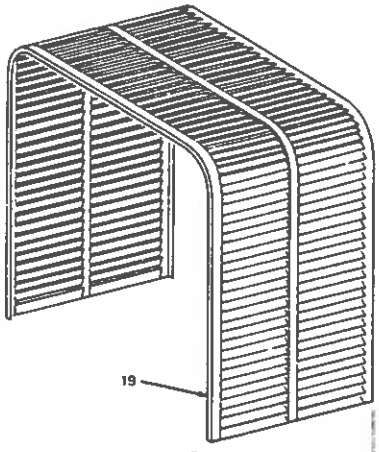
Ref. No.	Description	Part No.
1	Thermostat, One Pole (MT-1)	5813 0036 000
1	Thermostat, Two Stage (MT-2)	5813 0035 000
2	Knob, Thermostat	3301 0060 000
3	Label, Thermostat	3502 1781 000
4	Screws, Fl. Hd., 6-32 x 1/4	5202 7009 021
5	Clip, Thermostat	1403 0041 000
6	Switch, 25A, OEM	5216 0132 000
6	Switch, 25A, K & N	5216 0204 000
6	Switch, 63A, OEM	5216 0131 000
6	Switch, 63A, K & N	5216 0203 000
6	Switch, 25A, Electro	5216 0200 000
7	Screw, M4 x 10, Rd. Hd. (25A)	
7	Screw, 63A, M5 x 16, Rd. Hd.	
8	Knob, 25A, OEM "T1"	OEM "T1"
8	Knob, 25A, K & N	K & N S1B 6001
8	Knob, 63A, OEM	OEM "S4"
8	Knob, 63A, K & N	K & N S2B G001
8	Knob, Electro	EI 141747
9	Switch, Toggle, 600V	5216 0130 000
10	Relay, Fan, 24V Coil	5018 0008 000
11	Switch Assembly	5216 0199 000
12	Manual Reset Limit	4520 0012 000

RENEWAL PARTS IDENTIFICATION

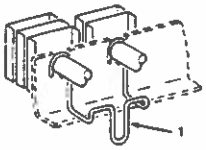


VIEW D-D
(MUH-25 THRU MUH-50 ONLY)

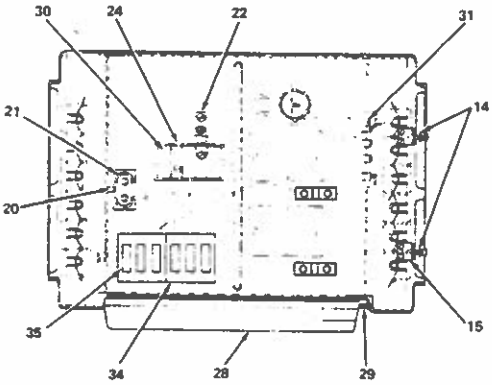
TERMINAL DOUBLER
(USED AS REQUIRED)



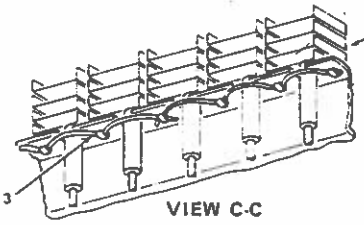
VIEW A-A



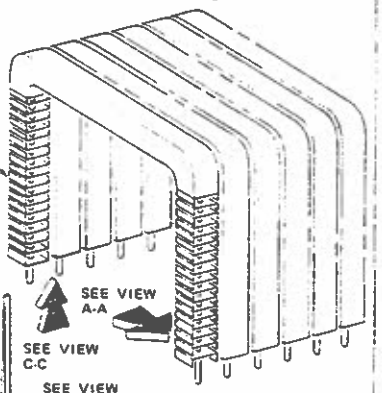
VIEW B-B

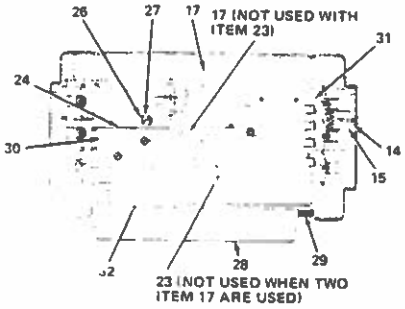


VIEW D-D
(MUH-07 THRU MUH-20 ONLY)

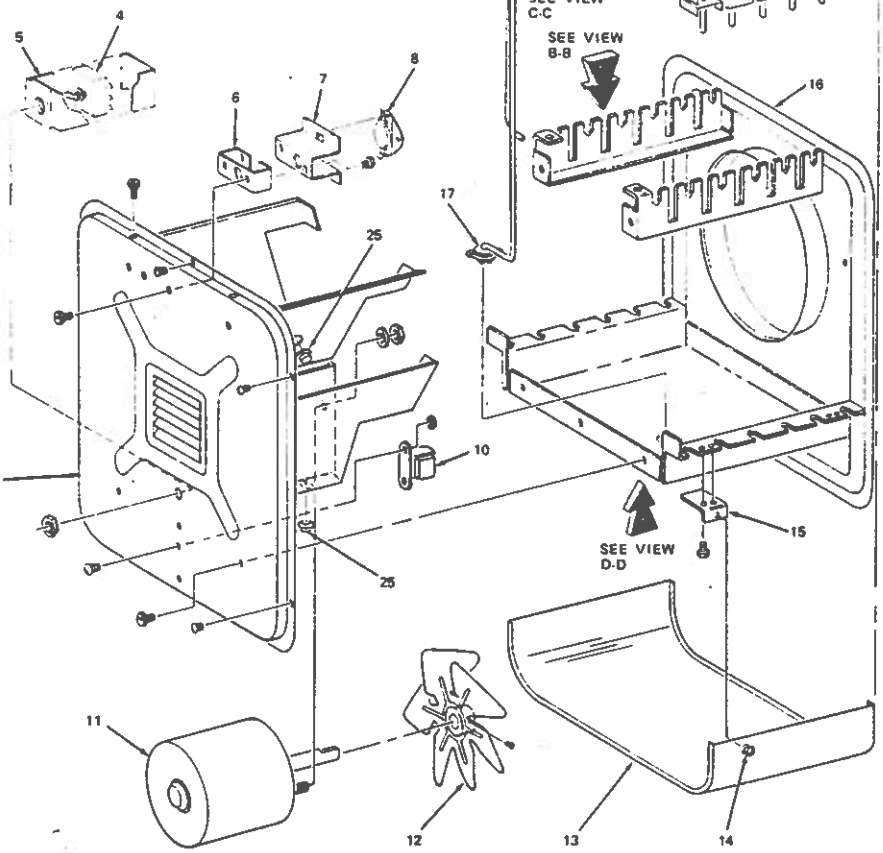


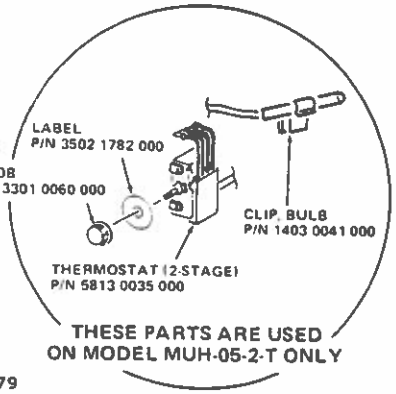
VIEW C-C





VIEW D-D
(MUH-03 THRU MUH-05 ONLY)





THESE PARTS ARE USED
ON MODEL MUH-05-2-T ONLY

RENEWAL PARTS IDENTIFICATION

Cat. No.	(9) Back Case	(10) Transformer	(11) Motor	(12) Fan Blade	(13) Cover	(16) Front Case	(18) Element Assy.	(19) Element Guard	(21) Capacitor
MUH-03-2	1425 0010 003	–	3900 0347 000	1210 0091 000	1402 0336 001	1425 0009 005	1802 0087 000	2504 0011 000	–
MUH-03-4	1425 0010 003	5814 0003 002	3900 0347 002	1210 0091 000	1402 0336 001	1425 0009 005	1802 0087 002	2504 0011 000	–
MUH-03-7	1425 0010 003	–	3900 0347 001	1210 0091 000	1402 0336 001	1425 0009 005	1802 0087 001	2504 0011 000	–
MUH-03-8	1425 0010 003	–	3900 0347 007	1210 0091 000	1402 0336 001	1425 0009 005	1802 0087 024	2504 0011 000	–
MUH-05-2	1425 0010 003	–	3900 0347 000	1210 0091 000	1402 0336 001	1425 0009 005	1802 0087 003	2504 0011 000	–
MUH-05-4	1425 0010 003	5814 0003 002	3900 0347 002	1210 0091 000	1402 0336 001	1425 0009 005	1802 0087 005	2504 0011 000	–
MUH-05-7	1425 0010 003	–	3900 0347 001	1210 0091 000	1402 0336 001	1425 0009 005	1802 0087 004	2504 0011 000	–
MUH-05-8	1425 0010 003	–	3900 0347 007	1210 0091 000	1402 0336 001	1425 0009 005	1802 0087 025	2504 0011 000	–
MUH-07-2	1425 0010 004	5814 0003 000	3900 0347 003	1210 0090 000	1402 0339 002	1425 0009 006	1802 0087 006	2504 0013 001	–
MUH-07-4	1425 0010 004	5814 0003 002	3900 0347 005	1210 0090 000	1402 0339 002	1425 0009 006	1802 0087 008	2504 0013 001	–
MUH-07-7	1425 0010 004	5814 0003 001	3900 0347 004	1210 0090 000	1402 0339 002	1425 0009 006	1802 0087 007	2504 0013 001	–
MUH-07-8	1425 0010 004	5814 0003 000	3900 0347 008	1210 0090 000	1402 0339 002	1425 0009 006	1802 0087 031	2504 0013 001	–
MUH-10-2	1425 0010 004	5814 0003 000	3900 0347 003	1210 0090 000	1402 0339 002	1425 0009 006	1802 0087 009	2504 0013 001	–
MUH-10-4	1425 0010 004	5814 0003 002	3900 0347 005	1210 0090 000	1402 0339 002	1425 0009 006	1802 0087 011	2504 0013 001	–
MUH-10-7	1425 0010 004	5814 0003 001	3900 0347 004	1210 0090 000	1402 0339 002	1425 0009 006	1802 0087 010	2504 0013 001	–
MUH-10-8	1425 0010 004	5814 0003 000	3900 0347 008	1210 0090 000	1402 0339 002	1425 0009 006	1802 0087 026	2504 0013 001	–
MUH-15-2	1425 0014 000	5814 0003 000	3900 0347 006	1210 0090 001	1402 0339 003	1425 0009 007	1802 0087 012	2504 0012 001	–
MUH-15-4	1425 0014 000	5814 0003 002	3900 0361 001	1210 0090 001	1402 0339 003	1425 0009 007	1802 0087 013	2504 0012 001	–
MUH-15-8	1425 0014 000	5814 0003 000	3900 0361 002	1210 0090 001	1402 0339 003	1425 0009 009	1802 0087 031	2504 0012 001	–
MUH-20-2	1425 0013 000	5814 0003 000	3900 0362 003	1210 0096 000	1402 0339 003	1425 0009 007	1802 0087 014	2504 0012 001	1432 0002 003
MUH-20-4	1425 0013 000	5814 0003 002	3900 0362 001	1210 0096 000	1402 0339 003	1425 0009 007	1802 0087 015	2504 0012 001	1432 0002 003
MUH-20-8	1425 0013 000	5814 0003 000	3900 0362 002	1210 0096 000	1402 0339 003	1425 0009 011	1802 0087 026	2504 0012 001	1432 0002 003
MUH-25-2	1425 0011 003	5814 0003 000	3900 0364 000	1210 0098 000	1402 0340 002	1425 0012 003	1802 0087 016	2504 0014 001	1432 0002 003
MUH-25-4	1425 0011 003	5814 0003 002	3900 0349 001	1210 0098 000	1402 0340 002	1425 0012 003	1802 0087 017	2504 0014 001	1432 0002 001
MUH-30-2	1425 0011 003	5814 0003 000	3900 0364 000	1210 0098 000	1402 0340 002	1425 0012 003	1802 0087 018	2504 0014 001	1432 0002 003
MUH-30-4	1425 0011 003	5814 0003 002	3900 0349 001	1210 0098 000	1402 0340 002	1425 0012 003	1802 0087 019	2504 0014 001	1432 0002 001
MUH-30-8	1425 0011 003	5814 0003 000	3900 0349 002	1210 0098 000	1402 0340 002	1425 0009 009	1802 0087 028	2504 0014 001	1432 0002 001
MUH-40-2	1425 0011 001	5814 0003 000	3900 0350 000	1210 0097 000	1402 0340 003	1425 0012 002	1802 0087 020	2504 0015 001	1432 0002 004
MUH-40-4	1425 0011 001	5814 0003 002	3900 0350 001	1210 0097 000	1402 0340 003	1425 0012 002	1802 0087 021	2504 0015 001	1432 0002 004
MUH-50-2	1425 0011 001	5814 0003 000	3900 0350 000	1210 0097 000	1402 0340 003	1425 0012 002	1802 0087 022	2504 0015 001	1432 0002 004
MUH-50-4	1425 0011 001	5814 0003 002	3900 0350 001	1210 0097 000	1402 0340 003	1425 0012 002	1802 0087 023	2504 0015 001	1432 0002 004
MUH-50-8	1425 0011 001	5814 0003 000	3900 0350 002	1210 0097 000	1402 0340 003	1425 0012 002	1802 0087 030	2504 0015 001	1432 0002 004

Cat. No.	(23) Relay	(24) Insulator	(30) Terminal Block Power	(31) Terminal Block, Control	(34) Fuse Block	(35) Fuse
MUH-03-2	–	–	5823 0004 000	5823 0001 000	–	–
MUH-03-4	5018 0004 008	2900 0030 000	5823 0004 000	5823 0002 000	–	–
MUH-03-7	–	2900 0030 000	5823 0004 000	5823 0001 000	–	–
MUH-03-8	–	–	5823 0004 000	5823 0001 000	–	–
MUH-05-2	–	–	5823 0004 000	5823 0001 000	–	–
MUH-05-4	5018 0004 008	2900 0030 000	5823 0004 000	5823 0002 000	–	–
MUH-05-7	–	2900 0030 000	5823 0004 000	5823 0001 000	–	–
MUH-05-8	–	–	5823 0004 000	5823 0001 000	–	–
MUH-07-2	5018 0003 004	–	5823 0004 000	5823 0002 000	–	–
MUH-07-4	5018 0004 008	2900 0030 000	5823 0004 000	5823 0002 000	–	–
MUH-07-7	5018 0003 004	2900 0030 000	5823 0004 000	5823 0002 000	–	–
MUH-07-8	5018 0003 004	–	5823 0004 000	5823 0002 000	–	–
MUH-10-2	5018 0003 004	–	5823 0004 000	5823 0002 000	–	–
MUH-10-4	5018 0004 008	2900 0030 000	5823 0004 000	5823 0002 000	–	–
MUH-10-7	5018 0003 004	2900 0030 000	5823 0004 000	5823 0002 000	–	–
MUH-10-8	5018 0004 008	–	5823 0004 000	5823 0002 000	–	–
MUH-15-2	5018 0005 012	–	5823 0004 001	5823 0002 000	–	–
MUH-15-4	5018 0004 008	2900 0030 000	5823 0004 000	5823 0002 000	–	–
MUH-15-8	5018 0005 008	–	5823 0004 003	5823 0002 000	2025 0002 000	2019 0007 010
MUH-20-2	5018 0006 008	–	5823 0004 001	5823 0002 000	–	–
MUH-20-4	5018 0004 008	2900 0030 000	5823 0004 000	5823 0002 000	–	–
MUH-20-8	5018 0005 000	–	5823 0004 002	5823 0002 000	2025 0002 000	2019 0007 008
MUH-25-2	5018 0005 012	–	5823 0004 002	5823 0002 000	2025 7002 000	2019 7008 077
MUH-25-4	5018 0005 012	2900 0030 000	5823 0004 001	5823 0002 000	–	–
MUH-30-2	5018 0005 012	–	5823 0004 003	5823 0002 000	2502 7002 000	2019 7008 079
MUH-30-4	5018 0005 012	2900 0030 000	5823 0004 001	5823 0002 000	–	–
MUH-30-8	5018 0006 008	–	5823 0005 000	5823 0002 000	2025 7002 000	2019 7008 080
MUH-40-2	5018 0005 012	–	5823 0005 000	5823 0002 000	2502 7002 000	2019 7008 079
MUH-40-4	*	2900 0030 000	5823 0004 002	5823 0002 000	2502 7002 000	2019 7008 079
MUH-50-2	5018 0005 012	–	5823 0005 000	5823 0002 000	2052 7002 000	2019 7008 080
MUH-50-4	*	2900 0030 000	5823 0004 002	5823 0002 000	–	–
MUH-50-8	5018 0006 008	–	5823 0005 000	5823 0002 000	2025 7002 000	2019 7008 078

*Two relays are used: 35A relay P/N 5018 0004 008, and 40A relay, P/N 5018 0005 012.

** Two fuse blocks are used: P/N 2025 7004 000, and P/N 2025 0001 000.

*** Two fuses are used: 30A 600v P/N 2019 7002 008, and 50A P/N 2019 7002 012.

(See following page for additional Renewal Parts Identification listing)

RENEWAL PARTS IDENTIFICATION (Cont.)

Ref. No.	Description	Part No.
1	Spring, Element (used on MUH-03 thru MUH-20 only)	5208 0073 000
1	Spring, Element (used on MUH-25 thru MUH-50 only)	5208 0073 001
2	Spring, Capillary Tube	5208 0072 000
3	Spring, Element Retainer	5208 0074 000
4	Switch (used on MUH-25 thru MUH-50 only)	5216 7076 001
5	Insulator (used on MUH-25 thru MUH-50 only)	2900 0031 000
6	Bracket Extension (used on MUH-15, MUH-20, MUH-40, and MUH-50 only)	1215 0282 000
7	Switch Bracket	1215 0256 000
8	Fan Delay Protector	4520 0010 000
14	Speed Nut	4100 7036 026
15	Bracket, Captive Screw (used on MUH-03 thru MUH-20 only)	1215 0291 000
15	Bracket, Captive Screw (used on MUH-25 thru MUH-50 only)	1215 0289 000
17	Protector, Linear Limit (used on MUH-03 thru MUH-05 only)	4520 0011 000
17	Protector, Linear Limit (used on MUH-07 thru MUH-20 only)	4520 0011 001
17	Protector, Linear Limit (used on MUH-25 thru MUH-50 only)	4520 0011 002
20	Clamp (used on MUH-20 thru MUH-50 only)	1417 5004 000
20	Bracket, Mounting, Capacitor (used on MUH-20-8 only)	1215 0314 000
22	Terminal Lug (used on MUH-07 thru MUH-50 only)	3504 7002 001
25	Bushing (used on MUH-20 thru MUH-50 only)	1213 7001 006
26	Washer, Ground (used on MUH-03 and MUH-05 only)	6401 0084 000
27	Screw, Ground (used on MUH-03 and MUH-05 only)	5202 0290 002
28	Louver (used on MUH-03 thru MUH-05 only)	3503 0036 000
28	Louver (used on MUH-07 thru MUH-20 only)	3503 0036 001
28	Louver (used on MUH-25 thru MUH-50 only)	3503 0036 002
29	Spring, Louver	5208 7005 001
32	Terminal Block, 3 Phase (used on MUH-05-02, MUH-07-02, and MUH-10-2 only)	5823 0003 000
32	Terminal Block, 3 Phase (used on MUH-05-8, MUH-07-8, and MUH-15-8 only	5823 0003 000
33	Terminal Doublers (used where required)	5819 7012 005

LIMITED WARRANTY

All products covered by this Instruction Sheet are warranted against defects in workmanship and materials for one year from date of sale. This warranty does not apply to damage from accident, misuse, or alteration; nor where the connected voltage is more than 5% above the nameplate voltage; nor to equipment improperly installed or wired or maintained in violation of this Instruction Sheet. This warranty is valid only in the fifty states of the United States. No other written or oral warranty applies. No employee, agent, dealer or other person is authorized to give any warranties on behalf of Emerson Electric Co.

The customer shall be responsible for all costs incurred in the removal or reinstallation and shipping of the product for repairs. Within the limitations of this warranty, inoperative units should be returned to the nearest Emerson authorized service center, or the Emerson Electric Co. Service Center, and we will repair or replace, at our option, at no charge to you with return freight paid by Emerson. It is agreed that such repair or replacement is the exclusive remedy available from Emerson Electric Co. and that EMERSON IS NOT RESPONSIBLE FOR DAMAGES OF ANY KIND, INCLUDING INCIDENTAL AND CONSEQUENTIAL DAMAGE. Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above exclusion or limitation may not apply to you.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

For the address of your nearest authorized service center contact Emerson Electric Co., P.O. Box 1132, Bennettsville, South Carolina 29512. (803/479-9063). Merchandise returned to the factory must be accompanied by a return authorization and service identification tag, both available from the above location. When requesting return authorization, include all catalog numbers shown on the product.

EMERSON

EMERSON ELECTRIC CO.
SERVICE CENTER

BOX 1132
BENNETTSVILLE, S.C. 29512

KEEP THIS FOR YOUR RECORDS

LIMITED WARRANTY **WARRANTY CERTIFICATE**

Raco Manufacturing and Engineering Co Inc., Emeryville California warrants this product to be in good working order for a period of five years from the date of purchase as a new product. In the event of failure of any part(s), due to defect in material or workmanship occurring within that five year period, Raco will, at its option, repair or replace the product at no charge for parts or labor. Any alteration of the product without instruction from Raco's Engineering Department will automatically void this warranty. If alterations of the unit are authorized by Raco, please complete the authorization form in the Owners Manual and return the form to Raco to ensure the warranty. Under no circumstances will Raco be responsible for consequential or secondary damages.

The defective product should be returned, insured and freight prepaid, securely packaged to the address listed below. Please call 1-800-722-6999 for a Return Authorization Number. Please include a copy of your sales receipt, the dialers serial number, and a detailed description of the problem you are experiencing.

Raco Manufacturing and Engineering Co Inc.
Service Department
1400 62nd Street
Emeryville, CA 94608

Detach here before mailing

WARRANTY REGISTRATION

IMPORTANT: Within 14 days of purchase, please compete this Warranty Registration. Detach the top portion, fold in half and drop in the mail. Postage is paid if mailed in the US. Otherwise, please return to:

Raco Manufacturing and Engineering Co Inc.
1400 62nd Street
Emeryville, CA 94608

Model: Verbatim VSS-8C
Serial Number V8-3787-0000
Date of Purchase _____
Name _____
Title/Position _____
Company/Organization _____
Division/Department _____
Address _____
_____
Telephone _____
Dealer's Name _____
Address _____
_____

The following additional information will assist us in our continuing efforts to provide you with products that meet your specific requirements.

1. **This autodialer is used in: ___wastewater, ___gas pipeline, ___remote equipment ___cold storage, ___chemical manufacture, ___energy generation, ___agriculture, _____other.**
2. **It uses the following types of transducers: ___pressure, ___temperature, ___flow, ___electrical detection, ___gas (all types), ___intrusion, ___float level, _____other.**
3. **I first became aware of this autodialer from: ___dealer showroom, ___ colleague, ___trade show, ___professional association, ___magazine inquiry, ___other.**
4. **I read the following publication(s) regularly:_____**

Please send me more information on the following quality products from Raco Manufacturing:

- **___Chatterbox CB-4/8**
- **___Chatterbox CB-16,24,32**
- **___Verbatim**
- **___Remote Supervisory Control**
- **___Analog Inputs**
- **___Nema 4X enclosure**
- **___Local Data Logging**
- **___Central Data Logging**
- **___Data Acquisition System**
- **___Extended Warranty**

Fagan Engineering - #701
731-2165

(CONTINUED)

FUNCTION	CODE
First Phone #	71
Second Phone #	72
Third Phone #	73
↓	↓
Eighth Phone #	78
Ninth (Callback) Phone #	79
Callback Execute	80
Tone vs Pulse Dialing	81
Station ID #	82
Alarm Trip Delay	83
Time Between Calls	84
Alarm Reset On/off 1=ON 0=OFF	85
Alarm Reset time	86
Autocall On/off 1=ON 0=OFF	87
Autocall time	88
Ring Delay	89
# of Alarm Readings	90
Callin Count	91
Dialout Count	92
Ack Alarm Count	93
Pwr off Count	94
Comm Mode	95
Time	96
Date	97
Access Code	98

Over The Phone:
- ## = ENTRY COMPLETE
- ** = CANCEL ENTRY
- * = DECIMAL POINT
- # = MINUS

Phone #s 607-974-6911 Pres
607-974-8407 Sec

If you continue to press the CANCEL ENTRY key, the Chatterbox® keeps reciting the speech string, each time erasing one more word.

If you wish to erase the entire string at once, press the MINUS key after you hear the speech you want to erase. This will erase only the speech string you are currently programming and will not affect any other programmed speech messages. The original default speech is restored. You may then either build a new speech string or move on to the next speech programming item by pressing the PROGRAM key.

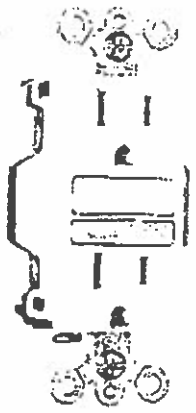
6.2 SPEECH PROGRAMMING SUMMARY:

To enter the Speech Programming Mode:	In the PROGRAM mode, after STATION ID speech is recited, press the POINT key.
To enter a word:	Enter the 3-digit code corresponding to that word.
Wait for CB-4 to recite word	
To accept the word:	Press the ENTRY COMPLETE key after the new word has been recited.
To erase the last word:	Press the CANCEL ENTRY key.
To erase entire string: (Restores default speech)	Press the MINUS key.
To move on to next speech programming item:	Press the PROGRAM key.
To review the programmed speech for the current message without altering it:	Press any single NUMBER key and then press the CANCEL ENTRY key.
To exit Speech Programming Mode:	Hold down the PROGRAM key to advance through speech programming items and then to next regular programming item. Or, press the NORMAL key to exit the PROGRAM mode entirely.

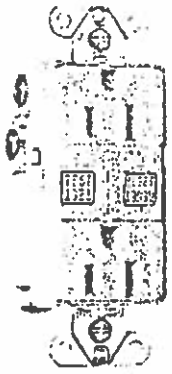
The sequence of Speech Programming items is:
STATION ID
CHANNEL 1 CLOSED CIRCUIT SPEECH
CHANNEL 1 OPEN CIRCUIT SPEECH
CHANNEL 2 CLOSED CIRCUIT SPEECH
CHANNEL 2 OPEN CIRCUIT SPEECH
CHANNEL 3 CLOSED CIRCUIT SPEECH
CHANNEL 3 OPEN CIRCUIT SPEECH
CHANNEL 4 CLOSED CIRCUIT SPEECH
CHANNEL 4 OPEN CIRCUIT SPEECH.

Ground Fault Circuit Interrupter Receptacles

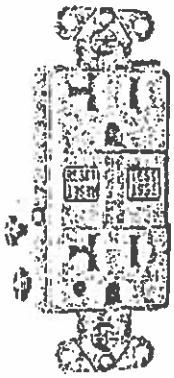
Standard & Specification Grade 15 & 20A., 120V.



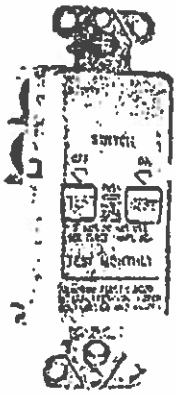
1591-RW



1591-SI



2091-SHGGRY



2081-SI

Standard Grade

Push-In Back and Side Wired Duplex

Rating			Description	NEMA Config.	Catalog Number
Amps	Feed-Thru Amps	Volts AC			
15	20	120	Feed-Thru, Brown	5-15R	1591-R
15	20	120	Feed-Thru, Ivory	5-15R	1591-RI
15	20	120	Feed-Thru, White	5-15R	1591-RW
15	20	120	Feed-Thru for 4600 Enclosure	5-15R	**1591-R46

**Available in Brown only.

Features

- Shallow design for easy installation.
- Choice of push-in or screw conductor termination.
- Open access screw conductor termination. Will accept solid or stranded wire.
- Easily accessible ground terminal not obstructed by mounting strap.
- Deeply cut, thick headed terminal screws improves screw driver grip.
- Large, easy to operate test/reset buttons.
- Supplied with matching plate.
- Combination slotted/Phillips head mounting and terminal screws.

Specification Grade

Side Wired Only Duplex

15	20	120	▲Feed-Thru, Brown	5-15R	*1591-S
20	20	120	▲Feed-Thru, Brown	5-20R	2091-S

▲For colors other than Brown, specify brown catalog number with color suffix as follows: Black-BK, Gray-GRY, Ivory-I, Red-RED (20A only), White-W.

*Available with indicator Light in Brown, Ivory-I, White-W. Add suffix -L to base catalog number. Example: 1591-SWL.

Features

- Shallow design.
- Screw terminals.
- 15 and 20 Amp.
- Hospital Grade available.
- Combination slotted/Phillips head mounting and terminal screws.
- Indicator light (power up) available.

Hospital Grade

Side Wired Only Duplex

Rating			Description	NEMA Config.	Catalog Number
Amps	Feed-Thru Amps	Volts AC			
15	20	120	▲Feed-Thru Receptacle	5-15R	*1591-SHG
20	20	120	▲Feed-Thru Receptacle	5-20R	*2091-SHG

*Available with indicator light in 15A Ivory-I and 20A Ivory-I, Red-RED, add suffix -L to base catalog number. Example: 1591-SHGIL.

▲For colors other than Brown, specify brown catalog number with color suffix as follows: Gray-GRY, Ivory-I, Red-RED, White-W.

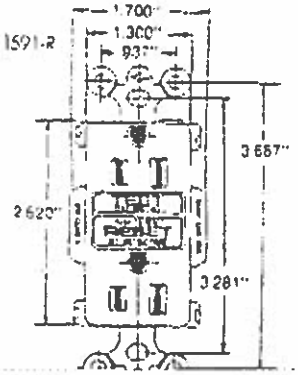
GFCI Switch/Motor Control

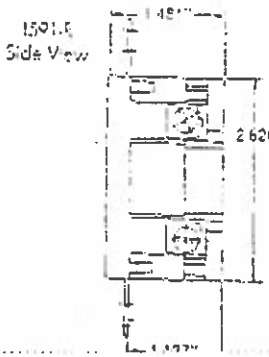
Rating		Description	Catalog Number
A.	V. AC		
20	120	GFCI, Switch/Motor Control, Ivory with Screw Terminals	2081-SI
20	120	GFCI, Switch/Motor Control, White with Screw Terminals	2081-SW

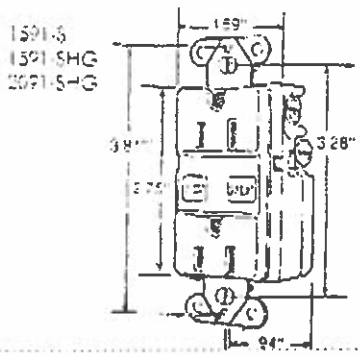
Application

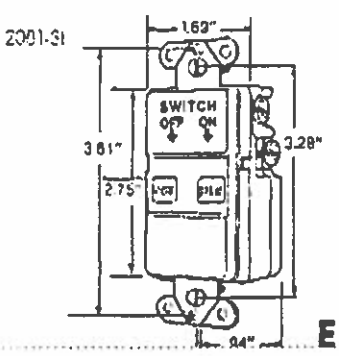
UL Listed as a miscellaneous motor controller with a 1½ HP switch rating. Provides hardwire GFCI protection for swimming pool equipment, spas, hot tubs, etc. with convenient on/off switching and reset capability. Also approved for use as an industrial motor controller. Combination slotted/Phillips head mounting and terminal screws.

Dimensions



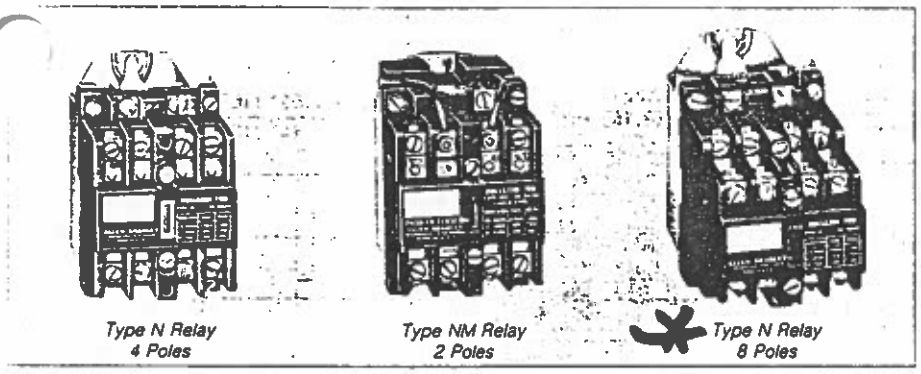




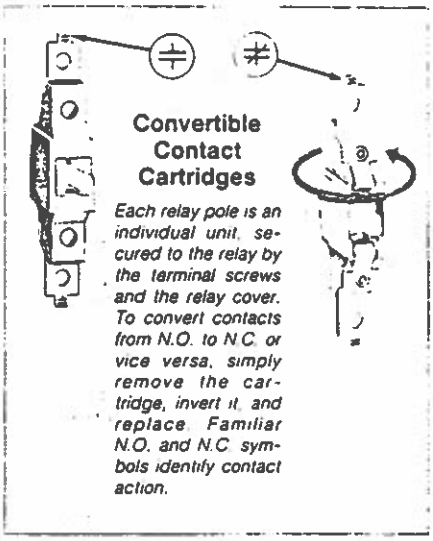


Compliances UL943 & UL498 (except 2081-S Series)

TYPE N ● AC ● CONVERTIBLE CONTACT CARTRIDGE ● 300V MAXIMUM



Type N Relay 4 Poles — *Type NM Relay 2 Poles* — *Type N Relay 8 Poles*



Convertible Contact Cartridges

Each relay pole is an individual unit, secured to the relay by the terminal screws and the relay cover. To convert contacts from N.O. to N.C. or vice versa, simply remove the cartridge, invert it, and replace. Familiar N.O. and N.C. symbols identify contact action.

DESCRIPTION — The Type N relay line includes electrically held relays (Type N), permanent magnet latched relays (Type NM) and various accessories such as pneumatic timing units, solid state timing units, mounting tracks, etc. The compact construction of these relays greatly reduces relay panel size and simplifies panel layout, wiring and maintenance. All relays feature convertible contact cartridges which can be arranged in any normally open and normally closed combination. Relays can be manually operated by pressing red bar at the center of the nameplate; red bar also gives visual indication of relay operation. Both Type N electrically held and Type NM latch relays have a pressure molded coil.

NORMALLY CLOSED CONTACTS — Listed relays are supplied with all contacts normally open. These contacts are readily convertible to normally closed in the field. Relays having combinations of normally open and normally closed contacts will be supplied at an additional charge of **$12** per relay.

OVERLAP CONTACTS — Overlap contacts (normally open contact closes before the normally closed contact opens) can be supplied at an additional charge of **$12** per relay. See Page 246 for information on kits for field installation of overlap contact cartridges.

BIFURCATED CONTACTS — Relays with bifurcated contact cartridges are available. Consult factory for ordering instructions.

CONTACT RATINGS — NEMA A300 AC and NEMA P300 DC. See Page 265

COIL VOLTAGES AND FREQUENCIES — Relays will be supplied at listed prices with coils suitable for the voltages and frequencies listed in price table note 1.

Type of Relay	Number of Contacts	RELAY ONLY				RELAY WITH PNEUMATIC TIMING UNIT	
		Open Type Without Enclosure		NEMA Type 1 General Purpose Enclosure		Open Type Without Enclosure	
		Catalog Number	Price	Catalog Number	Price	Catalog Number	Price
Electrically Held Relay	2	700-N200 1	$ 72	700-N201 1	$114	700-NT200 1	$240
	4	N400 1	96	N401 1	138	NT400 1	264
	6	N600 1	120	N601 1	162	—	—
	8	N800 1	144	N801 1	186	—	—
Permanent Magnet Latch Relay	2	700-NM200 1	156	700-NM201 1	198	700-NMT200 1	324
	4	NM400 1	180	NM401 1	222	—	—
	6	NM600 1	204	NM601 1	246	—	—

1 The catalog number as listed is not complete. To complete the catalog number, add a voltage and frequency identification number selected from the table below.

Relay Type	Hz	VOLTS								
		24	32	48	64	110	120	208	220	240
NM 2	60	A24	A32	A48	A64	—	A1	A20	—	A2
	50	B24	B32	B48	B64	A1	—	B20	A2	—

2 For Type NM Relays in 24, 32, 48 or 64 coil application refer to nearest Allen-Bradley Sales Office — See Page 658

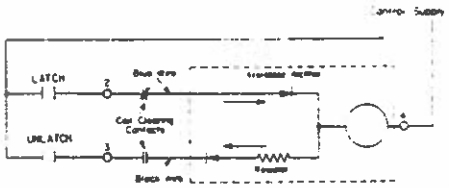
ACCESSORIES — A pneumatic timing unit, solid state timing unit, and various accessories are listed on Pages 245-246.

ORDERING INFORMATION — When ordering, specify the complete Catalog Number. Be sure to include coil voltage and frequency suffix. See table on this page.

MINIMUM OPERATING TIME FOR TYPE NM — For reliable operation, power to the latch circuit **must be** maintained for a minimum time of 75 milliseconds and power to the unlatch circuit **must be** maintained for a minimum time of 50 milliseconds.

SCHEMATIC DIAGRAM — (See Applicable Codes and Laws)

Type NM [illegible] Latch

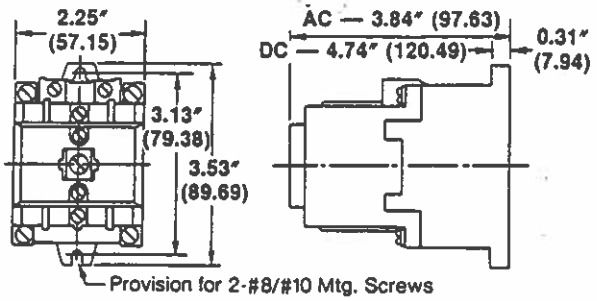


IMPORTANT — The "LATCH" and "UNLATCH" contacts must never be closed at the same time. Energizing both circuits simultaneously will cause damage to the relay.

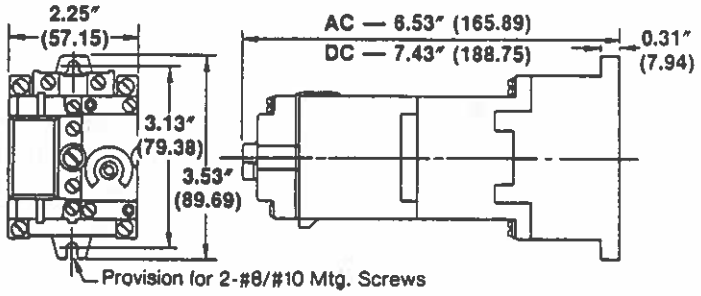
Approximate Dimensions — See Page 247.

APPROXIMATE DIMENSIONS AND SHIPPING WEIGHTS ● TYPE P, PH AND PK RELAYS

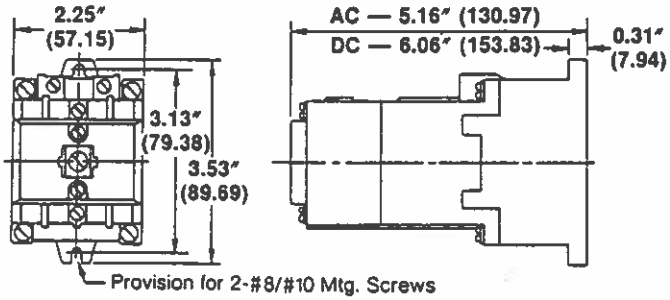
Dimensions shown in inches and (millimeters).



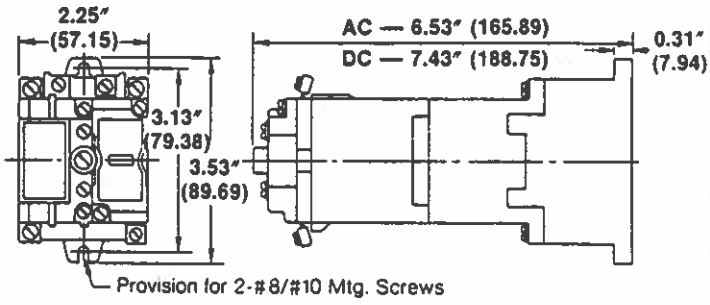
4 Pole Type P or PK Relay — 2 Pole Type PH Relay
Approximate Shipping Weight 1.5 lbs. (0.68 kg)



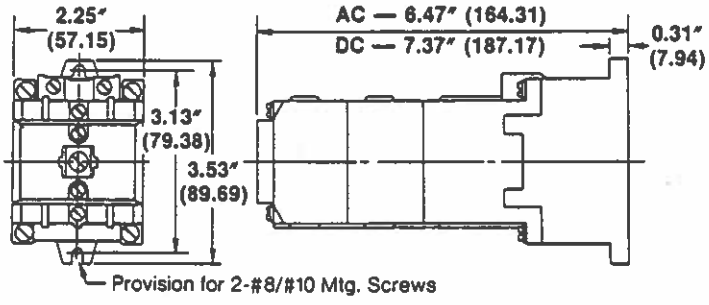
4 Pole Type P or PK Relay or 2 Pole Type PH Relay with Pneumatic Time Delay Attachment Approximate Shipping Weight 1.88 lbs. (0.85 kg)



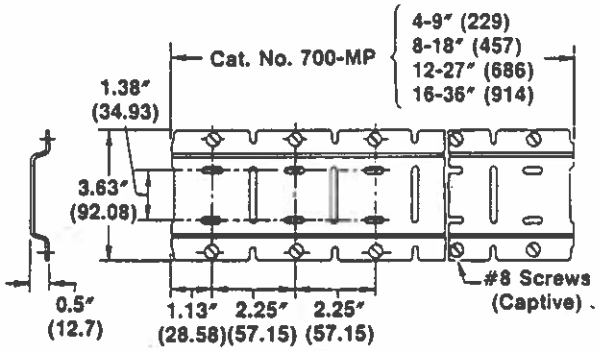
8 Pole Type P or PK Relay — 4 Pole Type PH Relay
Approximate Shipping Weight 1.75 lbs. (0.79 kg)



4 Pole Type P or PK Relay or 2 Pole Type PH Relay with Mechanical Latch Attachment Approximate Shipping Weight 2.13 lbs. (0.97 kg)

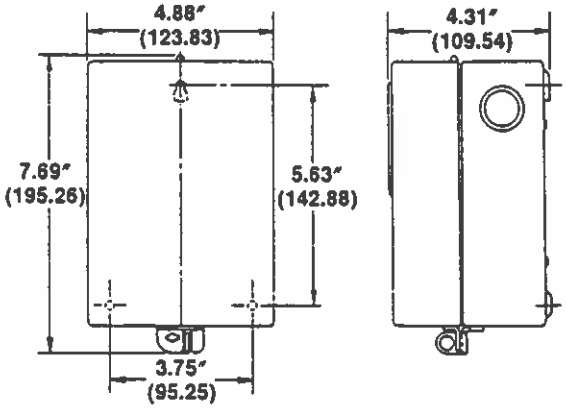


12 Pole Type P Relay — 6 Pole Type PH Relay
Approximate Shipping Weight 2.25 lbs. (1.02 kg)

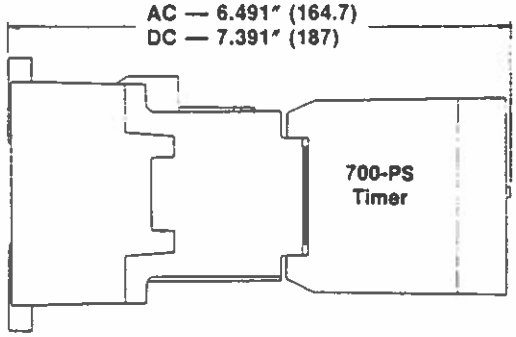


Universal Mounting Strip for Type P, PH, PK, N, NM, R, RM, RT, RTA Relays

Secure the mounting strip with 2 screws at each end relay position. Use a minimum of one screw at the 3rd, 5th, 7th, etc. relay positions. Alternate between upper and lower horizontal slots.



NEMA Type 1 Enclosure for Type P or PK Relay (2 to 4 Pole); Type PH Relay (1-2 Pole only); NEMA Type 1 Enclosure for other Type P, PH, PK, RT and RTA Relays
Catalog Number 700-N31 has same dimensions except the depth is 7″ (178mm).



Type PS Timer Mounted on a 4 Pole Bulletin 700 Type P or PK Relay or 2 Pole Type PH Relay. Approximate Shipping Weight 2.25 lbs. (1.02 kg)

Guardian

General Cable

Building Wire

Type: Bare Copper Wire

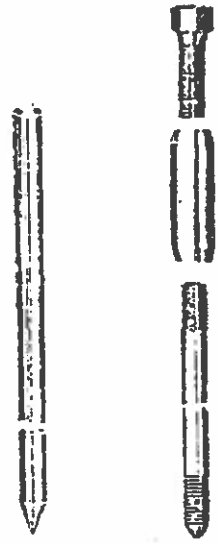
CATALOG NO.: **100-110**

APPLICATION: Bare copper is used for grounding wires, overhead electrical transmission and distribution systems, where high conductivity and flexibility is required.

STANDARDS: Soft Temper
Solid ASTM B3: 14 AWG - 2 AWG
Stranded ASTM B8: 6 AWG - 500 MCM

Size Awg or MCM	No. Of Strands	Strand Nom. Diam. (Mils)	Area Circular in Mils	Nom O.D. in Mils	Net Wt lbs/Mft
14 AWG	Solid	64.1	4.110	64	12.4
12 AWG	Solid	80.8	6.530	81	19.8
10 AWG	Solid	101.9	10.380	102	31.4
8 AWG	Solid	128.5	16.510	128	50
6 AWG	Solid	162.0	26.240	162	79.4
4 AWG	Solid	204.3	41.740	204	126.3
2 AWG	Solid	257.6	66.360	258	200.9
8 AWG	7/W	48.6	16.510	146	51
6 AWG	7/W	61.2	26.240	184	80.9
4 AWG	7/W	77.2	41.740	232	129
2 AWG	7/W	97.4	66.360	292	205
1 AWG	19/W	66.4	83.690	332	259
1/0 AWG	19/W	74.5	105.600	373	326
2/0 AWG	19/W	83.5	133.100	418	411
3/0 AWG	19/W	94.0	167.800	470	518
4/0 AWG	19/W	105.5	211.600	528	653
250 MCM	37/W	82.2	250.000	575	772
300 MCM	37/W	90.0	300.000	630	925
350 MCM	37/W	97.3	350.000	681	1080
400 MCM	37/W	104.0	400.000	728	1236
500 MCM	37/W	116.2	500.000	814	1542

GROUND RODS



Standard Sectional

Cop-R-Coat

Cop-R-Coat ground rods feature superior electrical conductivity and corrosion resistance. Constructed with a heavy copper coat bonded to a rigid steel core, ½", ⅝", ¾" and 1" diameters in 8 ft. and longer lengths listed by Underwriters Laboratories, Inc. Cast bronze clamps are recommended to maximize service life of the Cop-R-Coat grounding system.

Galvanized

High-tensile steel for maximum driving strength is pointed, then hot-dip galvanized for long service life at lower cost. Galvanized clamps are recommended to maximize the service life of this grounding system.

Stainless

Solid, 304 alloy stainless steel for use in highly corrosive environments. Also stainless clamps.

Standard Galvanized

Catalog Number		Nominal Size	Std. Pkg. Bdl.	Approx. Wt. per 100 Pcs.
Cop-R-Coat	Galvanized			
8425	7325	½" x 5'	10	330
8426	7326	½" x 6'	10	400
8428	7328	½" x 8'	10	560
8429		½" x 9'	10	590
8430	7330	½" x 10'	10	700
8436	7336	⅝" x 6'	10	600
8438	7338	⅝" x 8'	5	780
8440	7340	⅝" x 10'	5	1000
8448	7348	¾" x 8'	5	1100
8450	7350	¾" x 10'	5	1400
8470	7370	1" x 10'	3	2600
Sectional				
18438		⅝" x 8'	5	705
18440		⅝" x 10'	5	880
18448		¾" x 8'	5	1035
18450		¾" x 10'	5	1290
18470		1" x 10'	3	2325

Stainless

Catalog Number Stainless	Nominal Size	Std. Pkg.	Approx. Wt. 100 pcs.
9425	½ x 5	5	520
9438	⅝ x 8	5	832
9440	⅝ x 10	5	1040
9448	¾ x 8	5	1200
9450	¾ x 10	5	1500

Other size rods and fittings available on special order.

BELDEN

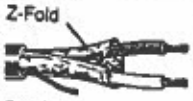
Sound, Broadcast, Audio and Instrumentation Cables

Description						Nominal Capacitances			
						pF/ft	pF/ft	pF/ft	pF/m

20 Gage (cont'd.)
Stranded Conductors (7x28)

Z-Fold  Beldfoil 100% Shield Coverage	**9154** UL 2464 300V 80C	1	U-500 500 U-1000 1000	U-152.4 152.4 U-304.8 304.8	11.9 12.5 22.8 23.6	.013	.33	.031	.79	.198	5.03	60	197	3100	328
						Product Description: Tinned copper, **PVC insulated,** twisted pair, Beldfoil aluminum-polyester shield, 22 AWG stranded tinned copper drain wire, beige PVC jacket. Color code: Black, Red.										

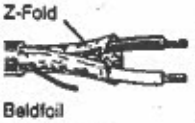
18 Gage
Stranded Conductors (16x30)

Z-Fold  Beldfoil 100% Shield Coverage	**8760** UL 2092 300V 60C	1	250 U-500 500 U-1000 1000 2000 5000	76.2 U-152.4 152.4 U-304.8 304.8 609.6 1524.0	7.5 13.7 15.1 27.4 28.7 58.7 148.2	.018	.46	.028	.71	.222	5.64	24	79	44	144
						Product Description: Tinned copper, **polyethylene insulated,** twisted pair, Beldfoil aluminum-polyester shield, 20 AWG stranded tinned copper drain wire, chrome PVC jacket. Color code: Black, Clear. **For Plenum version, see 88760 on page 128.**										
 Beldfoil 100% Shield Coverage	**9460** 300V 60C	1	U-500 U-1000	U-152.4 U-304.8	14.5 28.0	.018	.46	.026	.66	.222	5.64	27	89	49	161
						Product Description: Tinned copper, **polyethylene insulated,** twisted pair, Beldfoil aluminum-polyester shield, 20 AWG stranded tinned copper drain wire, chrome PVC jacket. The jacket and shield are bonded so both can be removed on automatic stripping equipment. Drain wire is on the inside of foil shield. Color code: Black, Clear.										

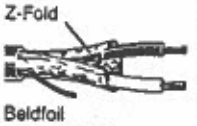
16 Gage
Stranded Conductors (19x29)

Z-Fold  Beldfoil 100% Shield Coverage	**8719** UL 2106 600V 60C	1	U-500 500 U-1000 1000 2000 5000	U-152.4 152.4 U-304.8 304.8 609.6 1524.0	24.1 25.0 47.2 51.2 104.3 247.8	.032	.81	.032	.81	.304	7.72	23	75	44	144
						Product Description: Tinned copper, **polyethylene insulated,** twisted pair, Beldfoil aluminum-polyester shield, 18 AWG stranded tinned copper drain wire, chrome PVC jacket. Color code: Black, Clear.										

14 Gage
Stranded Conductors (19x27)

Z-Fold  Beldfoil 100% Shield Coverage	**8720** UL 2106 600V 60C	1	U-500 500 1000 2000	U-152.4 152.4 304.8 609.6	32.5 33.4 70.5 137.9	.032	.81	.035	.89	.340	8.64	24	79	47	154
						Product Description: Tinned copper, **polyethylene insulated,** twisted pair, Beldfoil aluminum-polyester shield, 16 AWG stranded tinned copper drain wire, chrome PVC jacket. Color code: Black, Clear.										

12 Gage
Stranded Conductors (19x25)

Z-Fold  Beldfoil 100% Shield Coverage	**8718** UL 2106 600V 60C	1	U-500 500 1000 2000	U-152.4 152.4 304.8 609.6	48.4 52.4 102.8 206.8	.037	.94	.040	1.02	.400	10.16	25	82	49	161
						Product Description: Tinned copper, **polyethylene insulated,** twisted pair, Beldfoil aluminum-polyester shield, 14 AWG stranded tinned copper drain wire, chrome PVC jacket. Color code: Black, Clear.										

*Capacitance between conductors.
**Capacitance between 1 conductor and other conductors connected to shield.

MADE IN THE USA

THHN

Thermoplastic Insulated, Sheathed With Nylon or UL-listed equivalent.
Heat, Moisture, Oil & Gasoline Resistant[1]. 600 volt. Copper.
All sizes rated THWN-2; all stranded sizes rated MTW; AWG sizes 14 through 6 AWG rated AWM (105°C).
AWG sizes 14 through 1 rated VW-1 and larger sizes rated for CT use.

APPLICATIONS

Southwire Type THHN or THWN-2 conductors are primarily used in conduit and cable trays for services, feeders, and branch circuits in commercial or industrial applications as specified in the National Electrical Code[2]. When used as Type THHN, conductor is suitable for use in dry locations at temperatures not to exceed 90°C. When used as Type THWN-2, conductor is suitable for use in wet or dry locations at temperatures not to exceed 90°C or not to exceed 75°C when exposed to oil or coolant. When used as Type MTW, conductor is suitable for use in wet locations or when exposed to oil or coolant at temperatures not to exceed 60°C or dry locations at temperatures not to exceed 90°C (with ampacity limited to that for 75°C conductor temperature per NFPA 79). Conductor temperatures not to exceed 105°C in dry locations when rated AWM and used as appliance wiring material. Voltage for all applications is 600 volts.

SPECIFICATIONS

Southwire Type THHN or THWN-2 or MTW (also AWM) meets or exceeds all applicable ASTM specifications, UL standard 83, UL standard 1063 (MTW), Federal Specification J-C-30B, and requirements of the National Electrical Code.

CONSTRUCTION

Southwire Type THHN or THWN-2 or MTW copper conductors are annealed (soft) copper, insulated with a tough, heat and moisture resistant polyvinyl chloride (PVC), over which a nylon (polyamide) or UL-listed equal jacket is applied. Available in black, white, red, blue, green, yellow, brown, orange, or grey. Some colors standard, some subject to economic order quantity. Sizes 1-13 through 1,000 kcmil available in black only.

SOUTHWIRE

[1] Oil and gasoline resistance II as defined by Underwriters Laboratories.
[2] 1993 Edition.

Conductor		Insulation Thickness (mils)	Jacket Thickness (mils)	Nominal O.D. (mils)		Approx. Net Weight Per 1000' (lbs.)		Allowable Ampacities+			Standard Package
Size (AWG or kcmil)	No. Strands			Sol.	Str.	Sol.	Str.	60°C	75°C	90°C	
**14	19*	15	4	102	109	15	16	15	15	16	DNF°
**12	19*	15	4	119	128	23	24	20	20	20	DNF°
**10	19*	20	4	150	161	37	38	30	30	30	DQF^
**8	19	30	5		212		63	40	50	55	F
**6	19	30	5		250		95	55	65	75	E
4	19	40	6		319		153	70	85	95	C
3	19	40	6		346		189	85	100	110	BC
2	19	40	6		378		234	95	115	130	C
1	19	50	7		435		300	110	130	150	B
1/0	19	50	7		474		372	125	150	170	B
2/0	19	50	7		518		463	145	175	195	B
3/0	19	50	7		568		576	165	200	225	B
4/0	19	50	7		624		719	195	230	260	B
250	37	60	8		694		849	215	255	290	B
300	37	60	8		747		1010	240	285	320	B
350	37	60	8		797		1172	260	310	350	B
400	37	60	8		842		1332	280	335	380	B
500	37	60	8		925		1652	320	380	430	B
600	61	70	9		1024		1990	355	420	475	C
750	61	70	9		1126		2468	400	475	535	C
1000	61	70	9		1275		3263	455	545	615	C

* Solid construction available in sizes 14, 12, & 10 as Types THHN or THWN-2 or AWM only.
** Also suitable for 105°C appliance wiring material (AWM).
° Four 500' spools per carton.
^ Two 500' spools per carton.
+ Allowable Ampacities:
Allowable ampacities shown are for general use as specified by the National Electrical Code, 1993 Edition, sections 310-16.
60°C - When terminated to equipment for circuits rated 100 amperes or less or marked for #14 through #1 conductors. MTW wet locations or when exposed to oil or coolant.
75°C - When terminated to equipment for circuits rated over 100 amperes or marked for conductors larger than #1. THWN-2 when exposed to oil or coolant. MTW dry locations.
90°C - THHN dry locations. THWN-2 wet or dry locations.
All AWG sizes 14 through 1 rated VW-1. Larger sizes rated for CT use.

STANDARD PACKAGE CODE:
B = 1000' Reel
C = 500' Reel
D = 2500' Spool
E = 1000' Spool
F = 500' Spool
N = 2000' Carton
Q = 250' Carton

THHN or THWN-2 or MTW or AWM

RECOMMENDED SAMPLE SPECIFICATIONS:

(MTW OR THHN OR THWN-2)

Conductors shall be UL-listed Type MTW or THHN or THWN-2 gasoline and oil resistant II, suitable for operations at 600 volts as specified in the National Electrical Code. Conductors shall be annealed copper, insulated with high-heat and moisture resistant PVC, jacketed with abrasion, moisture, gasoline, and oil resistant nylon or UL-listed equivalent, as manufactured by Southwire Company or approved equal.

(AWM)

Conductors shall be UL-listed Type THHN or THWN-2 or MTW or AWM, suitable for operation at 600 volts at conductor temperatures not to exceed 105°C.

SOUTHWIRE
P.O. Box 1000
Carrollton, GA 30119-0001
404/832-4242

GALVITE® Rigid Steel Conduit

Strong, rigid, safe

GALVITE® Rigid Steel Conduit from LTV Steel offers the highest available strength, rigidity, ductility, system safety and protection. This product is suitable for the most demanding industrial/commercial building and construction service, in both indoor and outdoor environments.

LTV Steel produces GALVITE from high-quality, American-made carbon steel and certifies its domestic manufacture. Integrated Process Control throughout steel melting, strip rolling, forming and welding operations assures consistent properties, accurate sizes and excellent surface quality.

Product features

GALVITE is free from "burnt" or hard spots in the metal. Welds are smooth, strong and sound. The uniformity of metal composition and size assures easier threading and bending. The inside surface is smooth, clean and free from burns and rough spots, enhancing wire pulling.

GALVITE is hot-dipped galvanized inside and out. This tightly adhering finish doesn't chip, peel or flake off even under bending tests more severe than required by specification or encountered in normal installation. A secondary chromate treatment is applied over the galvanizing to extend surface protection.

GALVITE is readily formed and joined. Next to bendability, connecting ease is perhaps the feature most sought by those who work with rigid conduit. GALVITE threads are metallized with zinc to provide added corrosion protection. When short lengths are cut on the job, the ductility and uniformity make cutting and threading easier, an important source of installation economy.

Availability

Manufactured by the Electric Resistance Welded (ERW) process, GALVITE conduit is processed from high-quality domestic coils of flat rolled steels. It is produced in the nominal sizes and weights listed on the reverse side, and is furnished in 10' lengths with a coupling on one end.

GALVITE is supplied with color-coded end caps for easier size identification and thread protection.

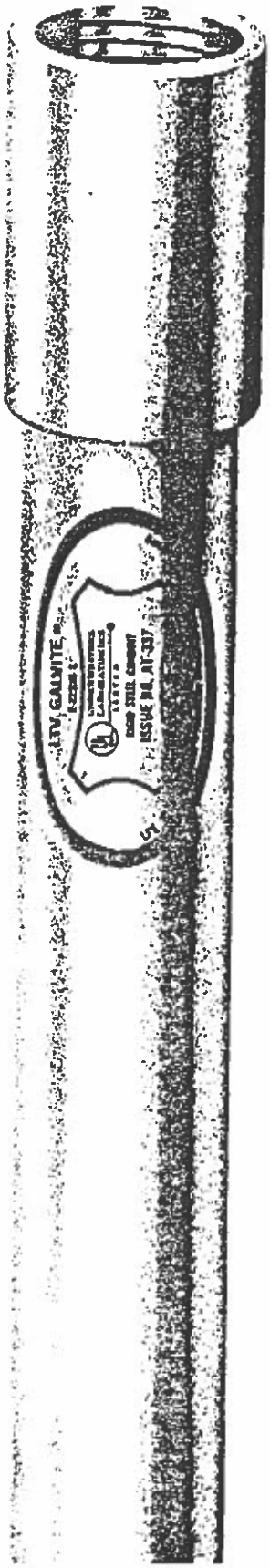
Quality

LTV Steel's Integrated Process Control system ensures GALVITE and other products meet the highest standards for quality and consistency. Continuous monitoring and the use of statistical process controls minimize variability throughout processing and allow for constant evaluation of product and process for refinement and improvement.

GALVITE is tested and inspected during manufacture for conformance to UL-6 and ANSI Specification C80.1.

Technical support

LTV Steel Tubular Products Company offers expert technical support to conduit customers. For information or assistance, write to the address listed on the reverse side.



GALVITE® Rigid Steel Conduit — Dimensions and Weights

Size	Diameters, In.		Weight, Lbs. Per 100 Ft.	Feet Per Bundle	Standard Lifts		Threads Per Inch
	External	Internal			Feet	Weight, Lbs.	
½	0.840	0.622	80.3	100	2500	2008	14
¾	1.050	0.824	106.4	50	2000	2128	14
1	1.315	1.049	154.4	50	1250	1930	11½
1¼	1.660	1.380	203.7	30	900	1833	11½
1½	1.900	1.610	251.0	30	800	2008	11½
2	2.375	2.067	338.0	—	600	2028	11½
2½	2.875	2.469	541.0	—	370	2002	8
3	3.500	3.068	706.0	—	300	2118	8
3½	4.000	3.548	849.0	—	250	2123	8
4	4.500	4.026	1003.0	—	200	2006	8
5	5.563	5.047	1343.0	—	150	2015	8
6	6.625	6.065	1798.0	—	*	*	8

*Shipped loose.

Conduit is furnished in nominal 10′ lengths, threaded both ends, with coupling screwed on one end and thread protector on the other. Conduit is always designated by its nominal inside diameter. All dimensions and weights shown above are nominal.

NOTE: Applicable tolerances: length ± ¼" (± 6.35 mm) — without coupling

OUTSIDE DIAMETER:

For trade sizes through 2": ± 0.015" (± 0.38 mm)
For trade sizes 2½" through 4": ± 0.025" (± 0.64 mm)
For trade sizes 5" and 6": ± 1%

GALVITE Conduit (Color Code — End Caps by Size)

Product	Size, In.	Color Code
GALVITE Rigid Conduit	¼" sizes	Red
	½" sizes	Black
	1" sizes	Blue

Steel Tubular Products

P.O. Box 1000
1315 Albert Street Youngstown, OH 44501-1000

TUP | 611Ra | 6/92 | 5M | WP
Printed in U.S.A.

Griffith
electrical control systems, inc.
(607) 648-9059

Design Brief 4/94

CALIBRATION REPORT

POINT LOOP # Ground Grid — DATE 1 / 19 / 95

POINT/LOOP LOCATION	~~DEVICE ADDRESS~~	POINT DESCRIPTION Edward Allen Land South Corning, New York
(REAL WORLD)		Control House Bldg & Service Ground
BLG Control House	~~ROUTE~~	DEPARTMENT RESPONSIBLE # OTS G — ENGINEERING DEPARTMENT # Tech
FLR 1	~~REG~~	VM UPDATE: —— — PROGRAM LOGIC: ——
COL None	~~BIT~~	PC UPDATE: —— — APPLICATION PROGRAM TESTED: YES (NO)
DEVICE LABEL CORRECT (YES) NO		PAGER SYSTEM YES (NO) — SOFTWARE TYPE: None

DIGITAL POINT DATA

~~ALARM DESCRIPTION~~ - None Required

~~ALARM~~ TESTED PASSED / FAILED — ~~ALARM CONTACT TYPE: N/O OR N/C~~

~~ALARM TRIPPED (HOW)~~

~~ANALOG~~ POINT DATA Ground Resistance Test Direct Method

~~% OF SPAN~~	INPUT	CALCULATED OUTPUT	AS FOUND OUTPUT	% ERROR	CALIBRATED OUTPUT	% FINAL ERROR	ACCURACY
~~0%~~	25'	—	.7Ω	0	3 OHMS MAX	0	100%
~~25%~~	50'	—	.3Ω	0	3 OHMS MAX	0	100%
~~50%~~							
~~75%~~							
~~100%~~							

(Hand Driven)

MANUFACTURER: Biddle MODEL # Ground Megger SERIAL # 09446-3 Cal: NIST 4/94

NOTES: Ground System Consists of Two 10' x 3/4" Copper Clad Ground Rods with #2 Bare Copper 30' Loop Continuous from Ground Bus in PP-1
Standard Electrical Ground "Direct Method Test"

CALIBRATED / ~~TESTED BY:~~ Edward Griffith — COORDINATOR: System Previously Passed NYSE&G 5 Minute Test For Service Connection [illegible]

DIGITAL/ANALOG CALIBRATION REPORT — DATE: 10/89 — REV. DATE: — DWG. NO. GECSI-9

3.13 GROUND RESISTANCE TESTING

A. Equipment

1. Ground Resistance Megger (hand or motor driven).

   a) Make: Biddle, Amprobe, Associated Research

B. Procedure

1. Direct Method: Refer to Standard Electrical Drawing 16950-2; Direct Method Ground Resistance Test.

   a) The Direct Method is the simplest way to make an earth resistance test. With this method resistance of the two electrodes in series is measured: The grid system and the plant water system. There are three (3) important limitations.

      1) The plant water pipe system must be extensive enough to have negligible resistance.
      2) The plant water pipe system must be metallic throughout, without any insulating couplings or flanges.
      3) The ground grid under test must be far enough away from the plant water pipe system to be outside its sphere of influence.

   b) As shown using a four terminal instrument, P1 and C1 terminals connect to the grid system under test, P2 and C2 terminals connect to the plant metallic water pipe system. With a three terminal instrument, connect X to grid, P and C to the pipe system. If the water system is extensive (covering a large area) its resistance should only be a fraction of an ohm. You can take the instrument reading as being the resistance of the ground grid.

2. Rate-of-Fall Method: Refer to Standard Electrical Drawing 16950-3; Rate-of-Fall Ground Resistance Test.

   a) As shown this three terminal test with a four terminal tester, P1 and C1 terminals on the instrument are jumpered and connected to the ground grid under test. With a three instrument connect X to the ground grid. The driven reference rod C should be placed as far from the grid as practical. This distance may be limited by the length of the extension wire available or the geography of the surroundings.

   b) Potential reference rod P is then driven in a number of points roughly on a straight line between the ground grid and C. Resistance readings are logged for each of the points; a curve of resistance vs. distance is drawn.

   c) Correct earth resistance is read from the curve for the distance is about 62% of the total distance from the earth electrode to C.

   d) Some rules of thumb on spacing P and C: For testing a single earth electrode, C can usually be placed 50 feet from the electrode under test with P placed about 31 feet away. With a small grid of two electrodes, C and usually be placed 100-125 feet from the electrode under test; P can correspondingly be plated about 62-78 feet away. If the earth electrode system is large, consisting for example of several rods or plates in parallel, the distance for C must be increased to possibly 200 feet, and for P to some 125 feet. You'll need even greater distance for complex electrode systems that consist of, say, a large number of rods or plates bonded together.

      Table 1 is a useful guide to reference probe location. You find the "maximum dimension" figure by taking the diagonal distance across your electrode system area. For example, if the area measures 100 x 100 feet, the diagonal equals about 140 feet; from the table you run down the first column to 140 and read across that P should be 365 feet from the electrode and C, 590 feet.

3. Table 1: Guide to Approximate Location of Reference Probes

Maximum Dimension, Feet	Distance To P, Feet	Distance To C, Feet
2	40	70
4	60	100
6	80	125
8	90	140
10	100	160
12	105	170
14	120	190
16	125	200
18	130	210
20	140	220
40	200	320
60	240	390
80	280	450
100	310	500
120	340	550
140	365	590
160	400	640
180	420	680
200	440	710

3.14 POLARIZATION TESTING

A. General

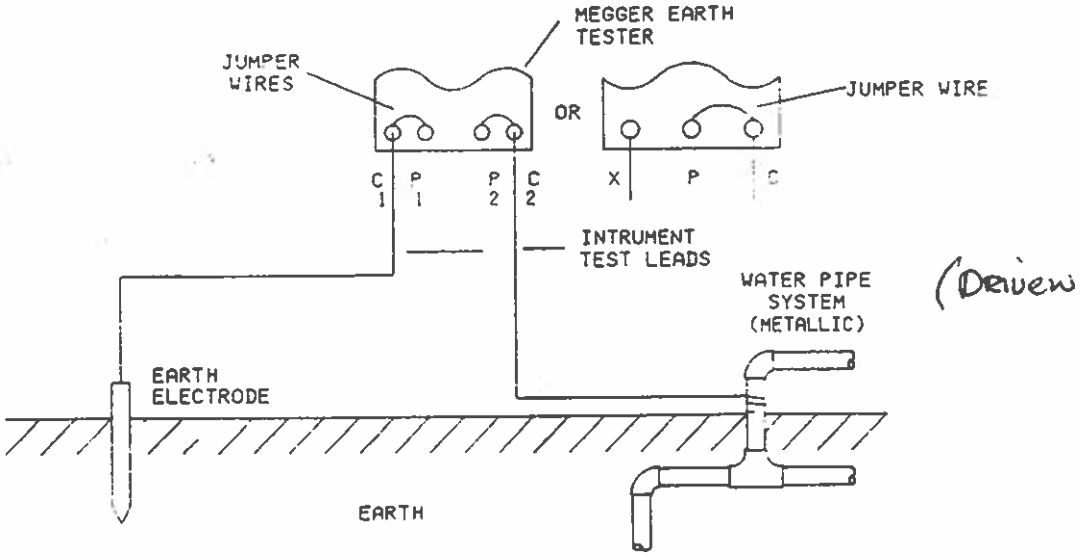
1. In accordance with Section 16050; Basic Materials and Methods, a Polarization test shall be performed on all 50 HP and larger motor prior to putting them into service.
2. Polarization Testing is the comparison ratio of insulation resistance reading taken at intervals of ten minutes and one minute (1) with a megger insulation tester.

B. Equipment

1. Megger insulation tester.
2. Instrument test leads.

C. Procedure

1. Conductor
   a) Disconnect conductor from source and feed to make sure line is 'dead'.
   b) Attach one lead to the conductor's insulation.
   c) Attach the other lead to the conductor.
   d) Complete circuit by inserting test leads into each part of the megger.
   e) Record first reading after one minute if heavy duty motor driven megger is used. (If hand operated megger is used, take reading at 30 seconds and 60 seconds).
   f) Record last reading after ten minutes.
   g) Discharge leads and remove megger insulation tester.
   h) Reconnect conductor to source and feed.
   i) Correct readings to a base temperature of 20°C.



DIRECT METHOD GROUND RESISTANCE TEST

DATE:	REV. DATE:
DWG. NO. 16950-2	

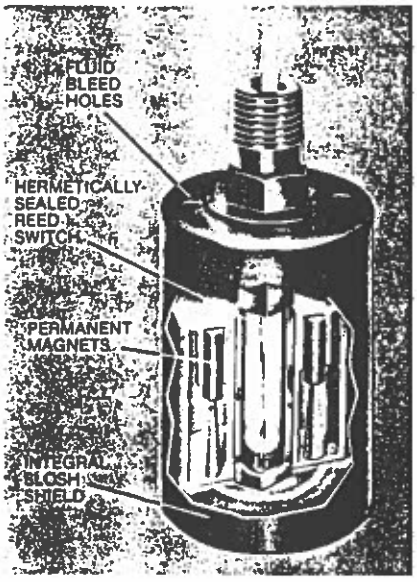
(4) 2.1 B-2 Containment

Single Station Level Switches

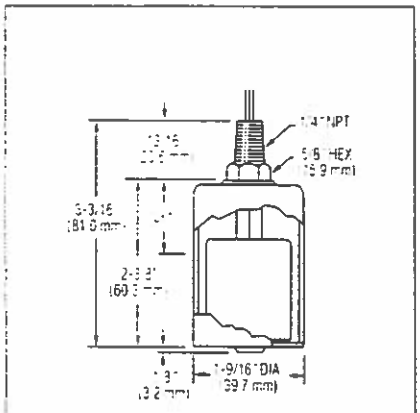
A

Level switch with integral slosh shield provides low-cost versatility for OEM applications.

Available in different materials to suit your specific needs.



Integral slosh shield reduces nuisance switching. Contact between the fluid and switch element is prohibited, ensuring long life and reliable operation. Shield end cap is easily removed if required. In operation, end cap is securely retained in place by a built-in locking mechanism.



Material	"L_1" Dimension
All Polysulfone	1-3/8" ± 1/4"
All Ryton	1-1/2" ± 1/4"
Ryton w/Buna-N Float	1-3/8" ± 1/4"
All Ultem	1-3/8" ± 1/4"

L_1 = Switch actuation level, nominal (based on a liquid specific gravity of 1.0).

Choice of materials:

All Polysulfone: Suitable for use in vending machines, potable water, dishwashers and food equipment.

All Ryton®: For chemical compatibility and high temperature applications to 300°F.

Ryton Body with Buna-N Float: Good for lightweight oils, fuels, hydraulic fluids.

All Ultem®: For use with a broad variety of chemicals. Call Express Service regarding your specific chemical.

Designed to provide high reliability and economy for OEM applications. The rugged design uses a float that rides along a square shaft to prevent float spiraling under vibratory conditions. It also features an integral slosh shield which significantly reduces nuisance switch cycling under turbulent liquid conditions. The switch construction assures free movement of the float even in viscous fluids.

Specifications:

Switch: SPST 20 VA
N.C. (Circuit opens on ascending level)
N.O. (Circuit closes on ascending level). (Standard)
(Field interchangeable by inverting float)

Lead Wires: #20 AWG., 24"

Mounting: Express Service versions: 1/4" NPT
Normal Delivery versions: 9/16-18THD

Wiring Diagram:

N.O. or N.C. operation is accomplished by inverting the float.

EXPRESS SERVICE
(1/4" NPT Mounting)

Order by Catalog Number

Material	Min. Liquid Sp. Gr.	Operating Pressure	Operating Temperature	Catalog Number	Price Each
All Polysulfone	.70	50 psig	−40°F. to +225°F.	A129510	$35.00
All Ryton	.95		−40°F. to +300°F.	A129520	$38.00
All Ultem	.70	50 psig	−40°F. to +225°F.	A129530	$35.00

Normal Delivery (4 to 6 Weeks)
(1/4" NPT Mounting)

Order by Catalog Number

Material	Min. Liquid Sp. Gr.	Operating Pressure	Operating Temperature	Catalog Number	Price Each
Ryton with Buna-N Float	.80	150 psig	32°F. to 180°F. (water) −65°F. to 230°F. (oil)	A129546	$38.00

Normal Delivery (4 to 6 Weeks)
(9/16-18THD)

Order by Catalog Number

Material	Min. Liquid Sp. Gr.	Operating Pressure	Operating Temperature	Catalog Number	Price Each
All Polysulfone	.70	50 psig	−40°F. to +225°F.	A129515	$35.00
All Ryton	.95		−40°F. to +300°F.	A129525	$38.00
Ryton with Buna-N Float	.80	150 psig	32°F. to 180°F. (water) −65°F. to 230°F. (oil)	A129548	$38.00
All Ultem	.70	50 psig	−40°F. to +225°F.	A129535	$35.00

Ryton is a registered trademark of Phillips 66 Company.
Ultem is a registered trademark of General Electric Company.

...Signal Producing Sensors

...trinsic safety with solid-state reliability.

- Since no explosion-proof enclosures are needed for sensor wiring, these units further provide economical installation.
- With encapsulated construction, 54800 Series Barriers are impervious to dust and moisture.
- Optional clip available for rail mounting.

For most non-voltage-producing devices located in a ha...dous area, a single zener barrier that is negative-earth-grounded (see preceding two pages) can be used for intrinsic ...

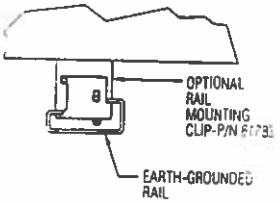
...strumentation that produces an output (signal conditioners) usually requires two barriers, one for each "floating" lead. In this case, select one of the 54800 Series dual ...nnel barriers shown here.

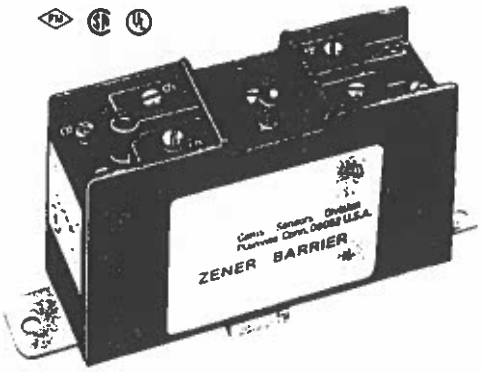
...non-voltage-producing sensor or switch is rendered intrinsically safe for hazardous ...tions when properly connected to the output of these Zener Barriers.

...table on Page M-2 for specific approval information.

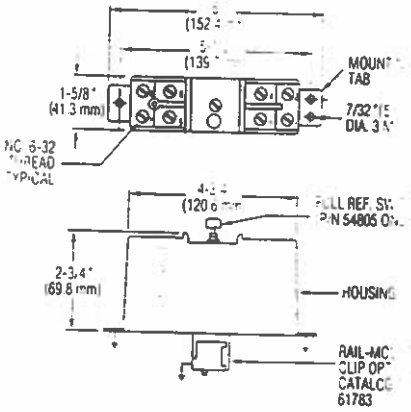
...al Mou...

...E-PAK Relays can be supplied on special order ...CLIP for rail mounting. Clip is in addition to stan... mounting tabs.



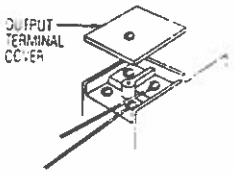


...ensions



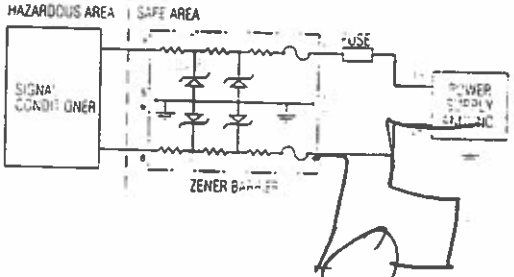
...tective Cover

Assures intrinsic safety integrity of sensor terminals and wiring.



Typical Wiring Diagr...

Positive dual-channel Zener Barrier with floating leads.



Display

GEMS

54[illegible] eries Dual Ch [illegible]el Zener Barriers Provide nt [illegible]c Safety to Sig [illegible]Producing Sensors

ELECTRONIC PRODUCTS

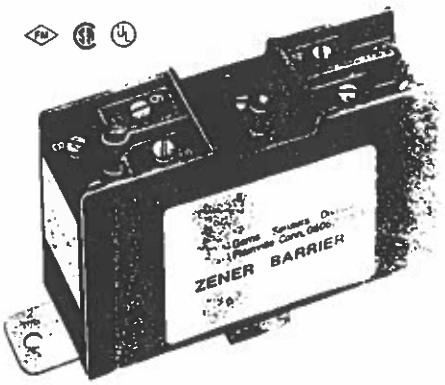
- Intrinsic safety with solid-state reliability.
- Since no explosion-proof enclosures are needed for sensor wiring, these units further provide economical installation.
- With encapsulated construction, 54800 Series Barriers are impervious to dust and moisture.
- Optional clip available for rail mounting.

For most non-voltage-producing devices located in a hazardous area, a single zener barrier that is negative-earth-grounded (see preceding two pages) can be used for intrinsic safety.

Instrumentation that produces an output (signal conditioners) usually requires two barriers, one for each "floating" lead. In this case, select one of the 54800 Series dual channel barriers shown here.

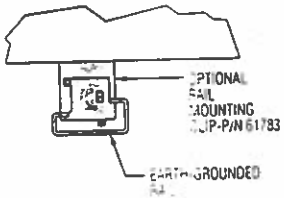
Any non-voltage-producing sensor or switch is rendered intrinsically safe for hazardous locations when properly connected to the output of these Zener Barriers.

See table on Page M-2 for specific approval information.

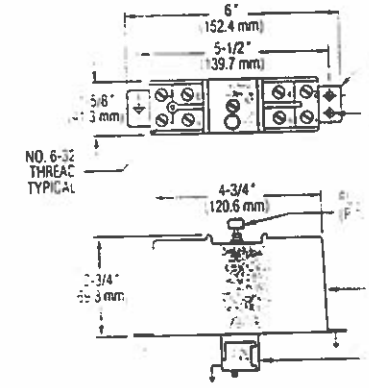


Op[illegible]ail Mounting

GEMS SAFE-PAK Relays can be supplied on special order with a clip for rail mounting. Clip is in addition to standard mounting tabs.

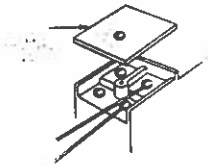


Dimen[illegible]ion:



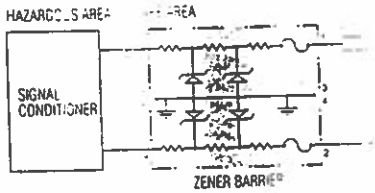
Prote[illegible]tive

Assures intrinsic safety integrity of sens[illegible] wiring.



Typi[illegible]l W[illegible]Diagram

Positive dual-channel Zener Barrier wit[illegible]

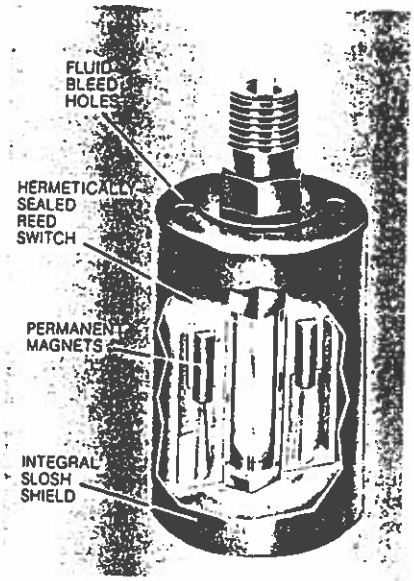


2.1 E INTERSTITIAL LEAK SENSOR (2)

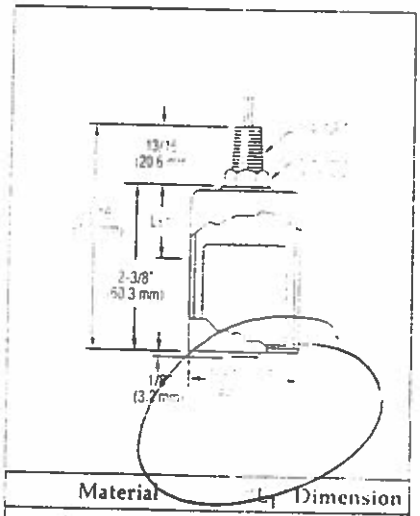
Single Station Level Switches

Level switch with integral slosh shield provides low-cost versatility for OEM applications.

Available in different materials to suit your specific needs.



Integral slosh shield reduces nuisance switching. Contact between the fluid and switch element is prohibited, ensuring long life and reliable operation. Shield end cap is easily removed if required. In operation, end cap is securely retained in place by a built-in locking mechanism.



Material	L_1 Dimension
All Polysulfone	1-3/8" = 1/4"
All Ryton	1-1/2" = 1/4"
Ryton w/Buna-N Float	1-3/8" = 1/4"
All Ultem	1-3/8" = 1/4"

*L_1 = Switch actuation level, nominal, based on a liquid specific gravity of 1.0

Choice of materials:

All Polysulfone: Suitable for use in vending machines, potable water, dishwashers and food equipment.

All Ryton®: For chemical compatibility and high temperature applications to 300°F.

Ryton Body with Buna-N Float: Good for lightweight oils, fuels, hydraulic fluids.

All Ultem®: For use with a broad variety of chemicals. Call Express Service regarding your specific chemical.

Designed to provide high reliability and economy for OEM applications. The [illegible] design uses a float that rides along a square shaft to prevent float spiraling under vibratory conditions. It also features an integral slosh shield which significantly reduces nuisance switch cycling under turbulent liquid conditions. The switch construction assures free movement of the float even in viscous fluids.

Specifications:

Switch: SPST 20 VA
N.C. (Circuit opens on ascending level)
N.O. (Circuit closes on ascending level). (Standard)
(Field interchangeable by inverting float)

Lead Wires: #20 AWG., 24"

Mounting: Express Service versions: 1/4" NPT
Normal Delivery versions: 9/16-18THD

Wiring Diagram:

N.O. or N.C. operation by inverting the float

EXPRESS SERVICE
(1/4" NPT Mounting)

Material	Order by Catalog Number: Min. Liquid Sp. Gr.	Operating Pressure	Operating Temperature	Catalog Number	Price Each
All Polysulfone	.70	50 psig	−40°F. to −225°F.	A129[illegible]	$[illegible]
All Ryton	.95		−40°F. to −300°F.	A129520	$38.00
All Ultem	.70	50 psig	−40°F. to −225°F.	A129530	$35.00

Normal Delivery (4 to 6 Weeks)
(1/4" NPT Mounting)

Material	Order by Catalog Number: Min. Liquid Sp. Gr.	Operating Pressure	Operating Temperature	Catalog Number	Price Each
Ryton with Buna-N Float	.80	150 psig	32°F. to 180°F. (water) −65°F. to 230°F. (oil)	A129540	$38.00

Normal Delivery (4 to 6 Weeks)
(9/16-18THD)

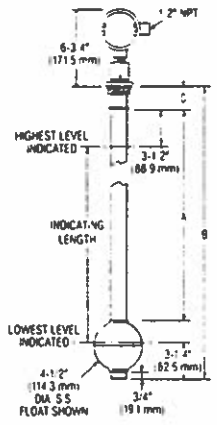
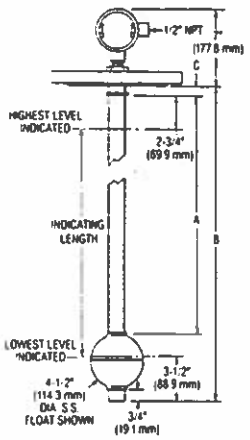
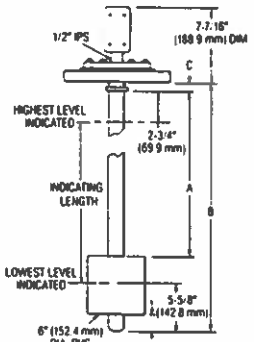
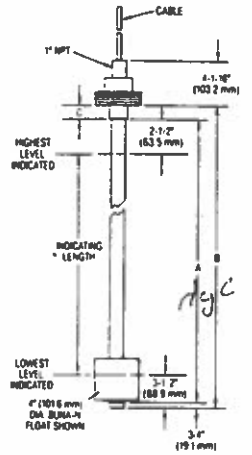
Material	Order by Catalog Number: Min. Liquid Sp. Gr.	Operating Pressure	Operating Temperature	Catalog Number	Price Each
All Polysulfone	.70	50 psig	−40°F. to −225°F.	A129515	$35.00
All Ryton	.95		−40°F. to −300°F.	A129525	$38.00
Ryton with Buna-N Float	.80	150 psig	32°F. to 180°F. (water) −65°F. to 230°F. (oil)	A129[illegible]	$[illegible]
All Ultem	.70	50 psig	−40°F. to −225°F.	A129[illegible]	$[illegible]

Ryton is a registered trademark of Phillips 66 Company.
Ultem is a registered trademark of General Electric Company.

Continuous Liquid Level Indicators

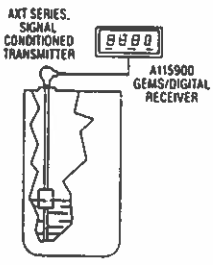
1. Transmitter Models and Materials

Each mounting type can be configured with materials, overall lengths and floats indicated in the tables below.

	XM-36425 Transmitter or XT-36425 Signal Conditioned Transmitter 1-7/8" (47.6 mm) — 12UN-2A Thread	XM-36490 Transmitter or XT-36490 Signal Conditioned Transmitter 5" ANSI Flange 150#, 300# or 600#	XM-36488 Transmitter 6" ANSI Flange, 150#	XM-66400 Transmitter 4" NPT
				
	A: Float Travel = Indicating Length + 1-3/4" (44.5 mm) ± 1/4" (6.4 mm) B: Overall Length = Indicating Length + 6-3/4" (171.5 mm) + C ± 1/8" (3.2 mm) C: Distance to Float Stop: 1-1/4" (31.9 mm) min. (specified by customer)	A: Float Travel = Indicating Length + 1-3/4" (44.5 mm) ± 1/4" (6.4 mm) B: Overall Length = Indicating Length + 6-3/4" (171.5 mm) + C ± 1/8" (3.2 mm) C: Distance to Float Stop: 1/2" (12.7 mm) min. (specified by customer)	A: Float Travel = Indicating Length + 1-3/4" (44.5 mm) B: Overall Length = Indicating Length + 9-3/8" (238.1 mm) + C ± 1/8" (3.2 mm) C: Distance to Float Stop: 7/8" (22.2 mm) min. (specified by customer)	A: Float Travel = Indicating Length + 1-3/4" (44.5 mm) ± 1/4" (6.4 mm) B: Overall Length = Indicating Length + 6-3/4" (171.5 mm) + C ± 1/8" (3.2 mm) C: Distance to Float Stop: 1/2" (12.7 mm) min. (specified by customer)
Stem Material	304/316 Stainless Steel		PVC	304 Stainless Steel
Flange Mounting Material	—	Carbon Steel or 304/316 Stainless Steel	PVC	304 Stainless Steel or Carbon Steel
Float Material	Buna-N, 316 Stainless Steel or Hycel		PVC	Buna-N or Hycel
Float Stop Material	304 Stainless Steel		PVC	304 Stainless Steel
Operating Temperature	− 40°F to + 230°F (− 40°C to 110°C), Water to + 180°F (82.2°C) — Buna-N Float − 40°F to + 230°F (− 40°C to 110°C) — Stainless Steel Float		+ 32°F to + 140°F (0°C to 60°C)	− 40°F to + 180°F (− 40°C to 82.2°C) — Buna-N Float − 40°F to + 225°F (− 40°C to 107.2°C) — Hycel Float
Operating Pressure, Max.	150 psi — Buna-N Float 600 psi — S.S. Float	150 psi — Buna-N Float 600 psi — S.S. Float	50 psi	100 psi — Buna-N Float 2000 psi — Hycel Float
Operating Voltage	10-30 VDC			
Overall Length, Max.	.180" (457.2 cm); please consult factory for longer lengths			
Electrical Connection	J-Box, Type GUAL 16		J-Box, PVC	Cable, (4) Conductor, Type-FSS-2, 30' L.*, Nitrile Jacket

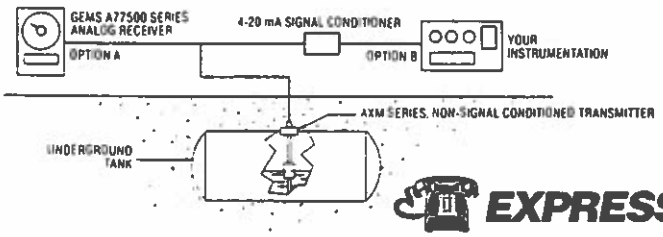
Notes: 1. Distances for highest and lowest level indicated are based on use in liquid with specific gravity of 1.0, and are approximate. *Unless otherwise specified
2. Indicating length must be specified in whole inches.

Typical Applications:



GEMS Transmitters monitor water, diesel or lube oils, chemicals and petrochemicals in industries such as pharmaceuticals, breweries, municipalities, automotive, textiles, pulp and paper, and others.

The AXM Series Transmitters shown below connect directly to any GEMS Analog Receivers (Option A), or signal conditioning anywhere within the control loop to allow the transmitter to send signals into your digital-based instrumentation (Option B), such as process controllers, data recorders, etc.



If your liquids eat away at metal, change over to these all plastic switches.

All PVC or All CPVC.
Excellent for plating applications.

Polysulfone Floats.
Low cost units are ideal for high volume use. Other wetted parts are stainless steel.
Specific Gravity: .65 min.

All-Teflon®
Ideal for use in viscous or contaminated liquids. Liquid Specific Gravity: .90 min.

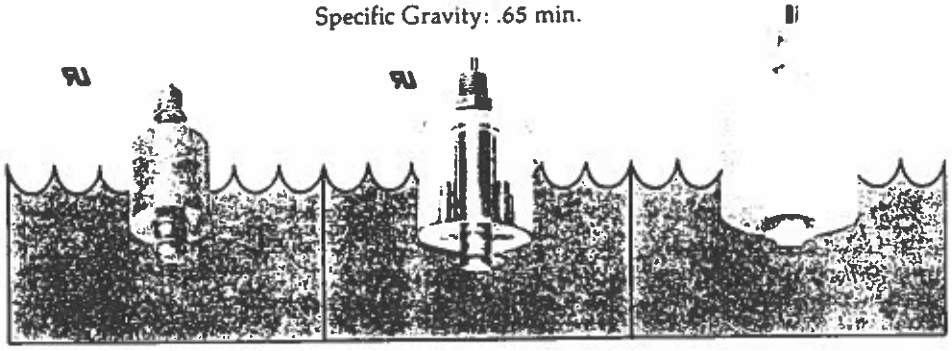
- No metal parts to corrode.
- Mounts vertically to top or bottom of tanks.

As durable as brass and stainless steel are, if you're monitoring corrosive chemicals you'll need these all plastic level switches. The inexpensive PVC or CPVC switches are well suited to chemical and plating applications.

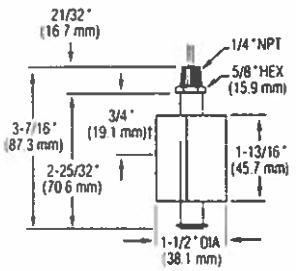
Polysulfone switches are low cost for high volume use. Limited use in oils and chemicals. See quantity discount prices.

Part No. A19735 is UL recognized.

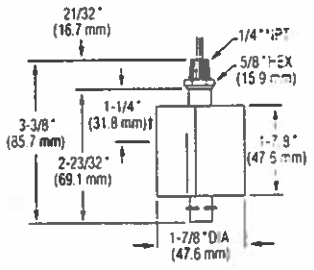
All-Teflon switches operate dependably in sticky or contaminated liquids. The problem of material build-up, which inhibits float travel, is minimized or eliminated. Compatible with a broad range of chemicals. Ideal for chemical metering pumps or processing and in plating systems.



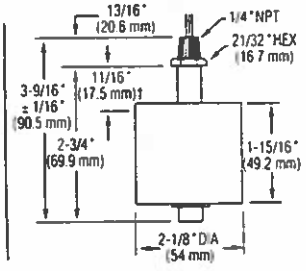
(A19735 or A74780)



(ALS-30 Series)

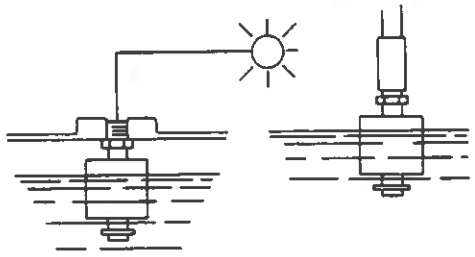


(A133299)



†L_1 = Switch actuation level, nominal (based on a liquid specific gravity of 1.0).

Installation:
Unit installs vertically, lead wires up or down.



Specifications:

Lead Wires:

PVC, CPVC and Polysulfone Models:
No. 18 AWG., 24" L., PVC

All-Teflon Models: No. 18 AWG., 24"-26" extended

Wiring Diagrams: See typical versions on Page A-1

EXPRESS SERVICE

Order by Catalog Number					
Float and Stem Materials	Operating Temperature	Pressure (Max.)	Switch Operation	Catalog Number	Price Each
PVC	0°F. to 125°F.	15 psi	SPST, 20 VA, N.O./N.C.	A19735*	$ 40.00
CPVC	0°F. to 180°F.	15 psi	SPST, 20 VA, N.O./N.C.	A74780*	$ 44.00
TEFLON	0°F. to +300°F.	40 psig	SPDT, 20 VA*	A133299	$300.00

Order by Catalog Number							
Material		Operating Temperature	Pressure (Max.)	Switch Rating	Catalog Number	Price Each		
Stem	Float					1-9 Pcs.	10-24 Pcs.	25-49 Pcs.
POLYSULFONE (ALS-30 Series)		−40°F. to +225°F.	50 psi	SPST, 20 VA	A46201	$34.00	$32.30	$30.60
				SPST, 100 VA	A46202	$40.00	$38.00	$36.00
				SPDT, 20 VA	A46203	$40.00	$38.00	$36.00

*Switch operation, N.O. or N.C., is selectable by inverting the float on the unit stem.

With exceptional flexibility, the ALS-800 Series is the perfect answer to the majority of level sensing application

• Lengths to 10 feet and longer, call Express Service. • Optional slosh guard. • UL recognized, File No. E45168. • Up to six separate level sensing stations. • CSA approved, File No. 30200. • Choice of mountings, materials, floats, switches and wiring. • FM approved for hazardous locations — File No. 1H3A2.AX.

Rugged construction and multiple options make the ALS-800 the best choice for broad general usage.

The following three pages contain all the information you'll need to complete the Check List below.

FAX IT! See Page I-1

See Page I-2 "Ordering with Check Lists" for tips on ordering custom units.

Suggestion: Use a copy of this page as your worksheet.

Check List for ALS-800 Series:

☑ Complete the list below and call our toll-free Express Line to order. These are custom units built-to-order. Please allow us 3 to 4 weeks for delivery.

1. Tank Mounting Type and Materials:

A. Tank Mounting: Type 1 ☐ Type 2* ☒ Type 3 ☐ Type 4 ☐ Type 5 ☐
*Type 2 Mounting—use only Float Catalog Number A26032.

B. Mounting Flange Material (Type 4 only): Carbon Steel ☐ Stainless Steel ☒

C. Housing Material (Type 5 only): Brass ☐ Stainless Steel ☒

D. Port Sizes (Type 5 only): 3/4" NPT (Brass) ☐ 1" NPT (316 S.S.) ☐

E. Stem and Mounting Material: Brass ☐ Stainless Steel ☒

F. Collars with Setscrews (required if overall length exceeds 72"; otherwise optional): Yes ☐ No ☐

G. Unit will be Mounted in: Top of Tank ☒ Bottom of Tank ☐

H. Tank Depth: _____

I. Media: _____; Specific Gravity: Unk

J. Maximum Temperature: 35 °F.; Maximum Pressure: 100 psig

2. Float Type (Part Numbers A26032, A10558, A14569, or A15666; one type float per unit):
Part Number: A14569 Your application's Temperature: 55 Pressure: 50PSI

3. Number of Actuation Levels (Level Stations; 1 to 6 per unit): 1

4. Distances to Actuation Levels and Length Overall (LO):

A.

Actuation Level	Distance to Actuation Level—Inches*	Switch Operation** (Check Type) N.O.	N.C.
L6			
L5			
L4			
L3			
L2			
L1	18"	X	X

B. Length Overall (L1 + Dimension B): 24" inches

*Measured from inner surface of mounting plug or flange.
**Switch position is "normal" with unit dry (tank empty).

5. Switch Type and Wiring (for all Actuation Levels):

A. Switch Type: SPST 20 VA ☐ SPDT 20 VA ☒ SPST 100 VA ☐

B. Wiring Group Number: I ☐ II ☒ III ☐ IV ☐

6. Options (Also see Temperature Sensing Options, Page I-31):

A. ALS-800-A Adjustable Option*: Yes ☐ *Available with Mounting Types 2, 3 and 4 only.

B. Lexan Slosh Shield Option*: Yes ☐ *Available with Mounting Types 3 and 4.

C. Junction Boxes: Yes ☐
Note: If a junction box is not selected, 24" lead wires will be supplied as standard.

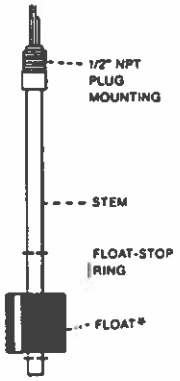
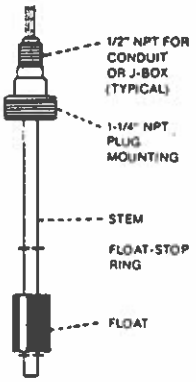
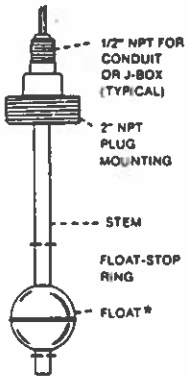
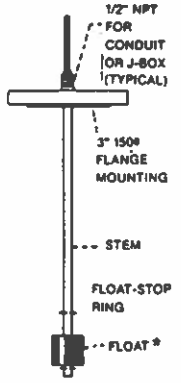
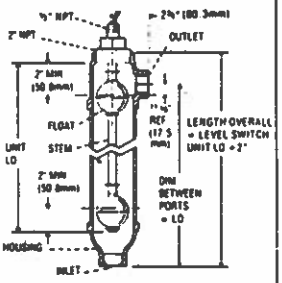
Temperature S
Capabilit
Available as O
See Page I-31 for

Multi Level Switches

1. Tank Mounting/ Stem Types.

Each Mounting Type can be configured with materials, stem lengths (LO) and floats indicated in table below.

Choose Mounting Type, first, before going on to other selections.

Type 1 1/2" NPT	Type 2 1-1/4" NPT†	Type 3 2" NPT†	Type 4 3" 150#	Type 5 External Mount
Mounted from inside of tank.	Plug mounted from outside of tank.	Plug mounted from outside of tank.	3" 150# Carbon Steel or 3" 150# Stainless Steel Flange mounted from outside of tank.	Brass versions— 3/4" Ports; Stainless Steel versions— 1" Ports
				

Stem & Mounting Material	Brass or 316 Stainless Steel			316 Stainless Steel (Stem)	Brass or 316 Stainless Steel
Max. Length—LO††	36"	60"	120"	120"	120"
Floats— Catalog Number	A10558 or A14569	A26032	A10558, A14569, A15666	A10558, A14569, A15666	A10588, A14569, A15666
Float Stops**	Brass Units—Beryllium Copper Grip Rings Stainless Steel Units—Stainless Steel ARMCO PH-15-7 MO Grip Rings				

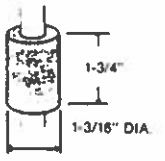
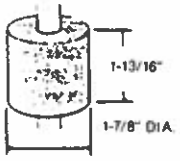
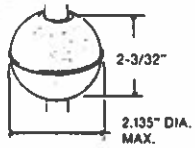
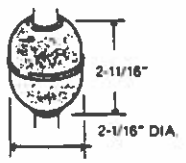
Float shown is example only; other floats available. See table above for compatible floats.

**Units greater than 72" overall length are supplied with collars with setscrews (made of same material as stem and mounting) in place of float-stop rings. Collars are optional on units less than 72" overall length.

†Available in the ALS-800A configuration for stem length adjustability. See Number 6, Options.

†† Lengths of over 10 feet available (consult Express Service).

2. Float Types

Buna-N* Use only with Type 2 Mounting.	Buna-N* For Type 1, 3, 4 or 5 Mountings.	Stainless Steel For Type 1, 3, 4 or 5 Mountings; units 72" or less (LO).	Stainless Steel For Type 3, 4 or 5 Mountings; units over 72" (LO).
			
Part Number A26032	Part Number A10558	Part Number A14569	Part Number A15666
Min. Media Specific Gravity .75	Min. Media Specific Gravity .55	Min. Media Specific Gravity .80	Min. Media Specific Gravity .75

*Other Wetted Material: Hysol

General Specifications for the different Stem and Float combinations:

	Type		Brass or S.S. Stem w/Buna-N Float	Brass or S.S. Stem w/S.S. Float LO=72" or Less	Brass or S.S. Stem w/S.S. Float LO Greater than 72"
Pressure Rating	1, 2, 3, 4		150 psi	750 psi	300 psi
	5	Brass	100 psi @ +70°F.		
		316 S.S.	150 psi	750 psi	300 psi
Operating Temperature	1, 2, 3, 4, 5		Oil: −40°F. to +230°F. Water: to +180°F.	−40°F. to +300°F.	

Continued on next page.

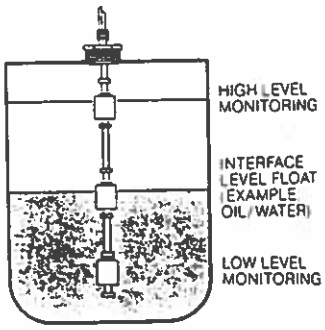
Multi Level Switches

3. Number of Actuation Levels.

Choose one float for each point when you require a switch action to occur (up to 6).

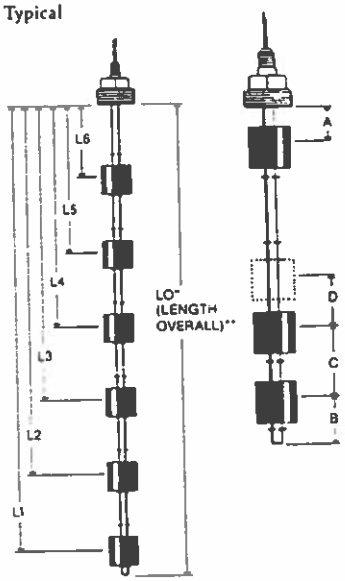
Typical Application:

These multi-level switches are ideal for monitoring the interface point between liquids of different specific gravities that are stored in the same tank. The float senses the different specific gravities of two different liquids. It pinpoints the top surface level of the heavier liquid, and the bottom level of the lighter liquids. For interface application information call Express Service.



4. Actuation Levels and Dimensional Data.

Actuation Levels*— Typical



* Actuation level distances and LO (overall unit length) are measured from inner surfaces of mounting plug or flange.

** Length Overall (LO) = L1 + Dimension B. See Section 1 (Mounting Types) for Maximum Length values.

Calculate the switch actuation levels you'll require. Follow the guidelines below.

All units 72" or less LO, and types 3, 4 and 5 units over 72" LO, with Buna-N floats:

A = 1-1/2" min. dist. to highest level (2" Type 5 only).
B = 2" min. dist. from end of unit to lowest level.
C = 3" min. dist. between levels.
D = 1/4" min. dist. between level actuation points (mom. oper.).

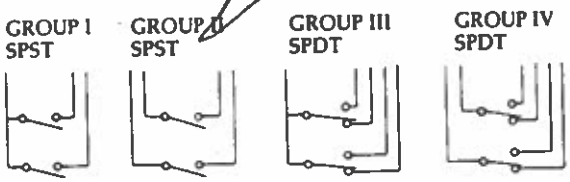
Types 3, 4 and 5 units over 72" LO with stainless steel Catalog Number A15666 floats:

A = 1-5/8" min. dist. to highest level (2" Type 5 only).
B = 2-1/2" min. dist. from end of unit to lowest level.
C = 4" min. dist. between levels.
D = 1/4" min. dist. between level actuation points (mom. oper.).

5. Switch Selection and Wiring Data.

• SPST or SPDT. • UL recognized configurations available.

Typical Wiring Diagrams:



For clarity, two actuation levels only are shown in each group diagram.

Notes:
1. Specify 20 or 100 VA.
2. SPST switches are available with 20 VA or 100 VA ratings; Multi-point units with 100 VA switches are not UL recognized nor CSA approved.
3. See Electrical Data, Page A-1.

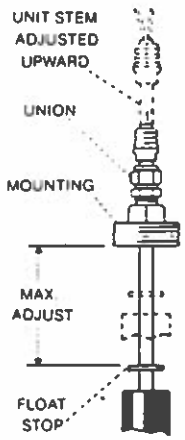
Wiring Color Code:

SPST SWITCHES				SPDT SWITCHES 20 VA				
Wiring	Group I	Group II		Group III		Group IV		
Unit Com.	Black	None		Black		None		
	NO/NC	SW. Com.	NO/NC	NO	NC	SW. Com.	NO	NC
L1	Red	Red	Red	Red	Wh/Red	Red	Wh/Red	Wh/Blk/Red
L2	Yellow	Yellow	Yellow	Yellow	Wh/Yel	Yellow	Wh/Yel	Wh/Blk/Yel
L3	Blue	Blue	Blue	Blue	Wh/Blue	Blue	Wh/Blue	Wh/Blk/Blu
L4	Brown	Brown	Brown	Brown	Wh/Brn	Brown	Wh/Brn	Wh/Blk/Brn
L5	Orange	Orange	Orange	Orange	Wh/Orn	Orange	Wh/Orn	Wh/Blk/Orn
Lo	Gray	Gray	Gray	Gray	Wh/Gra	Gray	Wh/Gra	Wh/Blk/Gra

Multi-point unit included in shaded areas can be supplied in UL recognized configurations.

• Options.

Add any, or all, of these options to your "basic" LS-800 unit to enhance the function and flexibility. The cost of these options are added to the total arrived at in the Price Calculation Tables.



A. ALS-800-A Adjustable Mounting

- Available for ALS-800 Series Mounting Types 2, 3 and 4.

Special cinch-nut on mounting allows stem to travel up or down for fine tuning your actuation points. The extent of adjustment depends on unit length and distance from mounting to highest float stop.

Notes:
Maximum overall length is limited to 72" with this option.

Catalog Prices*	
For Brass LS-800 units	$37.00
For Stainless Steel LS-800 units	$53.50

*Add the cost of this option to the total for your basic unit as calculated on the following page.

B. Lexan® Slosh Shield

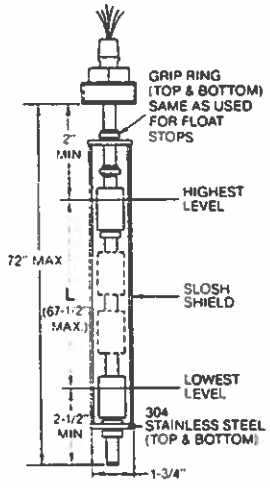
- Protect floats from turbulent or highly contaminated liquids.
- Available for ALS-800 Series Mounting Types 3 and 4, using float P/N A26032, only.
- Reduces nuisance switch actuation caused by liquid motion.
- Maximum temperature: 140°F.; Maximum pressure: 150 psi.

Just check the box for this option in the Check List on Page I-4. You'll receive your ALS-800 switch with this protective slosh shield mounted in place.

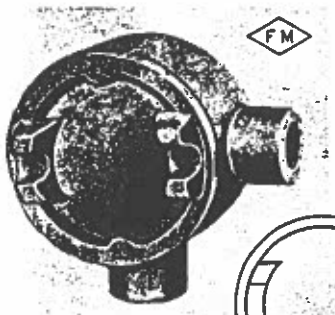
Price Calculation

'L' Dimension = Actuation Level Distance of highest level float subtracted from Actuation Level Distance of lowest level float (measured in whole inches; round up).

Slosh Shield Base Price				$36.00
'L' DIM.	×	Slosh Shield Cost per Inch $4.50	=	$
			Total*	$



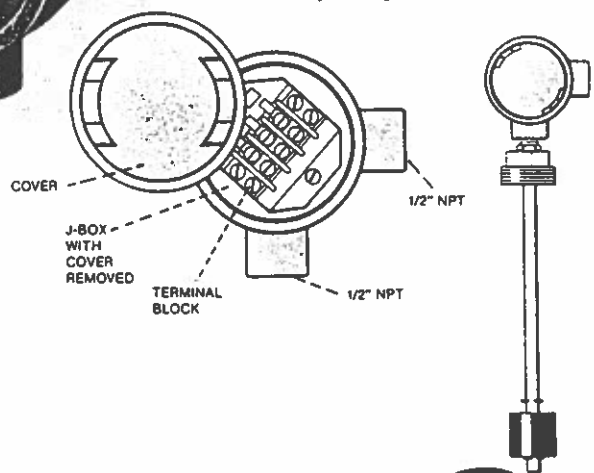
*Add the cost of this option to the total for your basic unit as calculated on the following page.



C. Optional J-Boxes with Terminal Strips or Solid State Controllers

For technical details and prices of GEMS Solid State Control Units, see Pages I-16 and I-17. These units automatically power 'on and off' equipment such as pumps, solenoid valves and alarms.

Optional J-Boxes with Terminal Strips greatly simplify wiring and installation of these multi-level switches. They are mounted to your switch and pre-wired at the factory before delivery. See price below.



Feraloy Junction Boxes:

These junction boxes are explosion-proof, watertight and comply with NEC requirements: Class I, Groups C and D; Class II, Groups E, F and G; Class III. They are also FM approved for Class I, Division 1, Group D when used with stainless steel floats, P/N 14569.

Catalog Price*	
J-Box with Terminal Strip	$90.00

*Add the cost of this option to the total for your basic unit as calculated on the following page.

Turn to next page for prices.

GEMS®

Instruction Bulletin
No. 51650

Zener Barrier SAFE-PAKS

ST-54806
ST-54807

Installation and Maintenance

GEMS 54800 Series SAFE-PAK is a solid-state, energy-limiting device for transmitting direct current signals of less than 30V and less than 60 ma in an intrinsically safe manner. The unit is designed to be used in conjunction with indicating equipment in hazardous areas defined as Class I, Division I, Group D.

The ambient temperature operating range of these devices is 0 to 60 degrees C (+32 to +140 degrees F). Instructions in this bulletin cover GEMS Zener Barrier SAFE-PAKS ST-54806 (for use where circuit common is earth-ground-referenced) and ST-54807 (for use where circuit source voltage (V+) is earth-ground-referenced).

1. Only one sensor and one receiving station per channel may be connected to a barrier. (See Fig. 1) The nature of the sensor must be that it is a non-voltage-producing, resistive termination containing no energy-storing devices.

2. The barrier and receiving station must be located in a non-hazardous location.

3. Mounting bracket on barrier must be connected to earth ground from both mounting points and two lines for redundancy. Grounding should be adequate for conduction of line generated fault currents. The impedance of either line to earth should be maintained at less than one ohm.

To serve multiple tank installations, additional barriers may be placed in an enclosure using a common earthing ground. (See Fig. 2) In this enclosure, the intrinsically safe wiring should be segregated from non-intrinsically safe wiring by independent raceways, wiring trays or other adequate means to insure installation integrity. Minimum field wiring insulation thickness not to be less than .010".

5. Hazardous area field wiring will store energy due to distributed capacitance and inductance in proportion to its length. It is recommended that characteristics (available from the manufacturer) of the cable be known and judged against the length of run and atmosphere of exposure. The following chart is presented as a guideline in determining the limits of reactance for signal loops in the hazardous area wiring for this barrier.

Group		Capacitance	Inductance
D	Propane	2.0 μF	6 mh

Example: Typical values of capacitance for twisted pair of copper wires is between - 60 pf per foot. Using max. value of 60 pf/Ft., inductance of a typical twisted pair is between 0.10 and 0.20 μh/Ft. The maximum values of capacitance or inductance should be used to determine field wiring length.

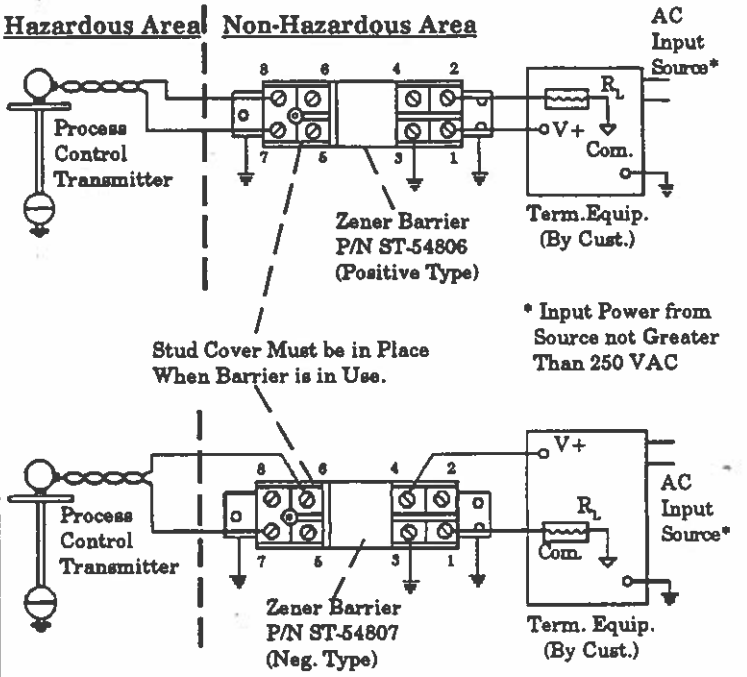
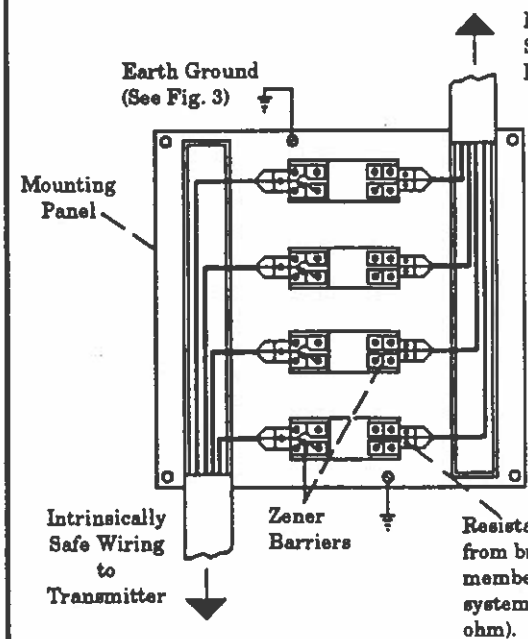


FIG. 1 Installation Diagrams



Important: All barriers used for multiple barrier mounting must be of the same polarity.

FIG. 2 Multiple Barrier Mounting

6. Field Testing of Barrier

A. Never conduct tests while circuit is active. The use of instruments between input and output terminals will bypass barrier.

B. All testing is to be done with circuit inactive using the following instruments:

1. Ohmmeter with resolution down to less than 1 ohm
2. D.C. power supply with output of 0 to +40 VDC
3. D.C. voltmeter

C. Test Performance (See Fig. 4)

Step 1: Disconnect all leads to unit under test except earthing/mounting tabs.

Step 2:

(a) Measure the resistance between terminals 1 & 7 and then 2 & 8. This resistance should be 270 ohms ±5% (± instrument tolerance).

(b) Measure the resistance between terminals 5 & 3 and then terminal 5 and the bracket. Both readings should be below one ohm.

(c) Apply 35 volts to terminals 7 (+) and 5 (common). Then read the voltage between terminals 1 (+) and 3 (common)*. This voltage must be between 28 and 32 volts. In the same fashion, conduct this same test with the voltage impressed across 8 (+) and 5 (common) and measure the output across 2 (+) and 3 (common).

(d) Connect an ohmmeter between mounting bracket (not the mounting screw) and the earth ground reference. The reading must be less than one ohm. The barrier must pass all parts of this test or it is unacceptable.

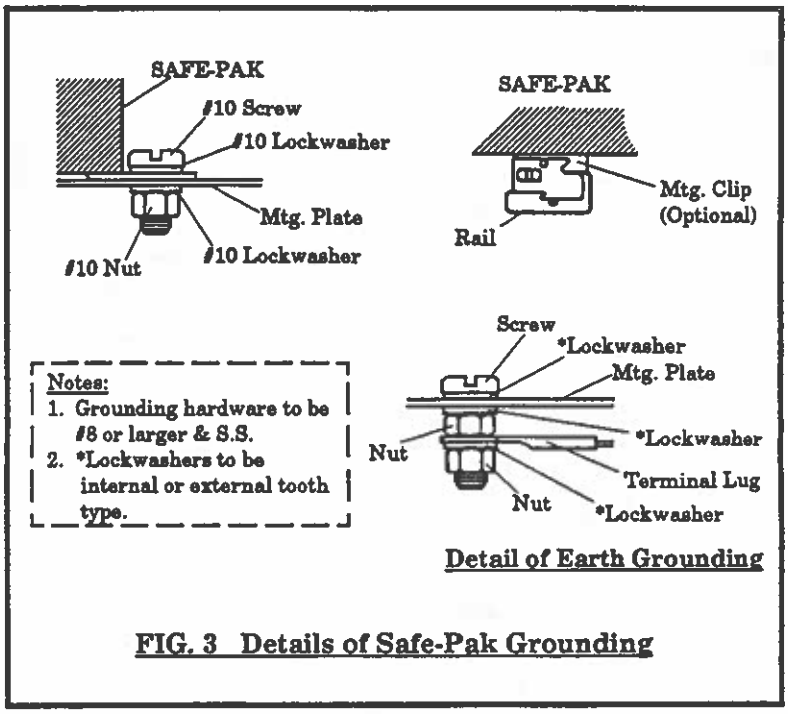


FIG. 3 Details of Safe-Pak Grounding

7. Every effort should be made to keep these barriers clean and free of contaminating atmospheres. A periodic check should be made to verify that they are in good condition, both physically and electrically.

8. Each sensor must have its own ground return wire to pin 5.

Note: The fuses located in the legs 7-1 and 8-2 are rated at 60 ma. Therefore, care should be exercised in testing this device so that no accidental current greater than 60 ma enters or leaves pins 1 or 2.

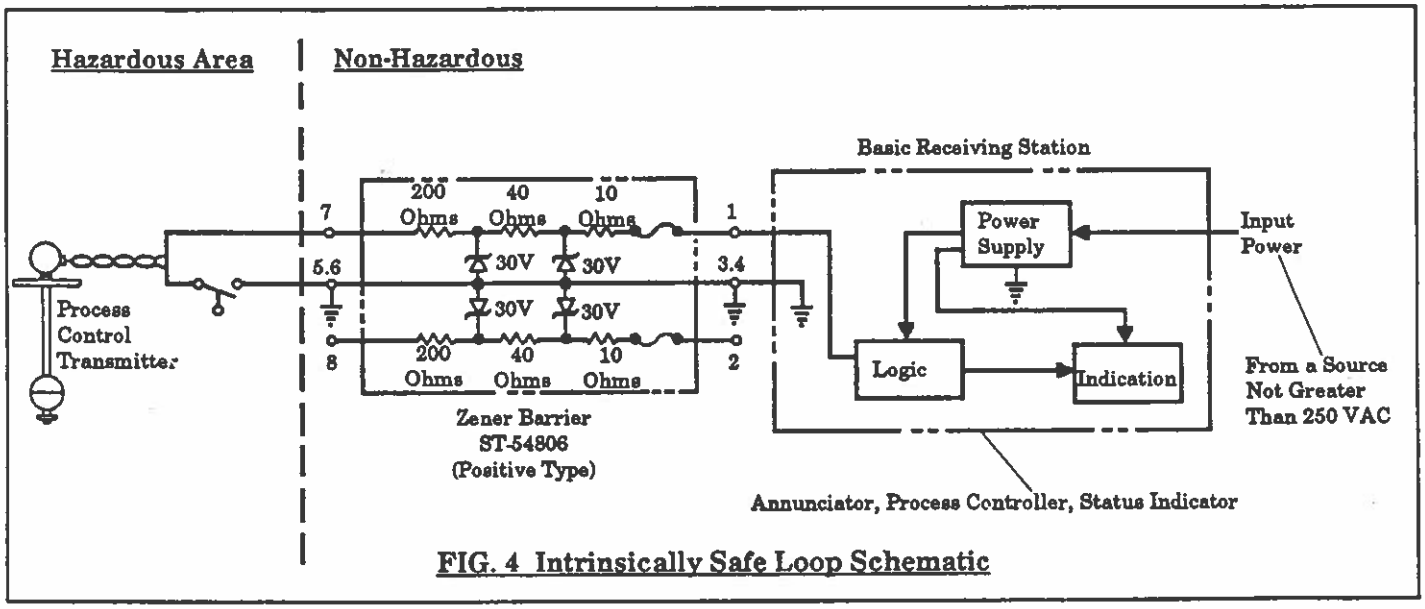


FIG. 4 Intrinsically Safe Loop Schematic

Imo Industries Inc.
Gems Sensors Division
1 Cowles Road
Plainville, CT. 06062-1198 U.S.A.
Tel. 203-747-3000 Fax. 203-747-4244

P/N 51650
Rev. G

2.1B.2

RITEC

QUOTATION: DA125AR3, Rev.A
DATE: January 13, 1995
PHONE: (716) 271-3170
FAX: (716) 271-5259

Griffith Electrical Control
491 Conklin Rd.
Chenango Forks, NY 13746

Attn: Ed. G.

Ref: Leachate Level

PLEASE ORDER: **Drexelbrook Engineering C/O**
Ritec Enterprises, Inc.
26 Saginaw Drive
Rochester, NY 14623

SALES: Bill Assman/Rick Walker

Application: Leachate Level ***Material:*** Water-based leachate
Pressure: Atm. ***Temperature:*** Ambient
Comments: Underground, Steel tank

Item	Qty	Description	Unit Price	Total
1	2	Drexelbrook Engineering Company, Continuous Level Measurement System Model # 508-45-9/RUHE to include:	$[redacted]	$[redacted]

A. Electronic Unit: #408-8232-9

Power:	24 VDC
Output:	4 to 20 mA
Housing:	Explosionproof
Mounting:	Integral

B. Sensing Element: #700-1-22

Description:	3/8" OD TFE
Insertion length:	108"
Connection:	3/4" NPT 316 SS

C. Instruction Manual (1 per system)

NOTE: If PO received by noon 1/13, systems will ship on 1/20.

Delivery: 1-2 Weeks ARO Terms: Net 30 FOB: Horsham, PA

**** Quote Valid for 30 Days ****

Receiving Department

... our intention to ensure your order be received in perfect condition. Please indicate below.

☐ Package damaged
☐ Equipment missing
☐ Equipment damaged
☐ Received OK

☐ Comments ______________________

____

____

____

... # ______
... # 36534
Packed by: ______

Phone # ______
Date: ______

... you for supplying this information

Sharon Sholette
Shipping Supervisor

... have a crisis because of any of the above ... please telephone (215) 674-1234 and ask for Tony Oliver or Sharon Sholette.

DREXELBROOK
Engineering Company
440-117-32
EDO# 11-94-241

DREXELBROOK
Engineering Company

CONDITIONS OF SALE

DREXELBROOK ENGINEERING COMPANY

205 KEITH VALLEY ROAD HORSHAM, PA 19044 215-674-1234

All orders of Customer of equipment, accessories and other products (the "Equipment") from Drexelbrook Engineering Company ("Drexelbrook") are subject to the following conditions of sale. This order being intended by Drexelbrook and customer to be the final, complete and exclusive of the terms and conditions of their agreement.

1. **DELIVERY**: Unless otherwise specified, delivery of Equipment will be f.o.b. point of shipment at Horsham, Pennsylvania. Delivery schedules represent Drexelbrook's best estimate of delivery times, made for customer's convenience. No delivery date shall form any part of the agreement between Drexelbrook and customer. Drexelbrook shall in no event be liable for any loss incurred by Customer due to Drexelbrook's failure to make shipment on the date scheduled. Any Equipment described as being "in stock" is subject to prior sale. This order may not be cancelled, except upon Customers obtaining the written consent of an officer of Drexelbrook thereto, and only if Customer pays to Drexelbrook upon cancellation Drexelbrook's charges for work performed and commitments entered into with respect to this order through the date of cancellation.

2. **PAYMENT**: Prices are quoted f.o.b. point of shipment and payment shall be made net 30 days after shipment, with 1% discount for payment 10 days after shipment unless otherwise specifically agreed or quoted in writing by Drexelbrook. Interest on any Customer balance not paid within 30 days after shipment shall be paid at the rate of 1 1/2% per month, compounded monthly, from the date on which net payment becomes due. If shipment or any other act or condition affecting payment for the Equipment is ready for shipment, and the Equipment shall thereafter be held at Customer's risk and expense.

If partial shipments are made, proportionate payments shall become due and payable on each such shipment. If Customer fails to perform any term or condition hereof or if Drexelbrook at any time has doubt of Customer's financial responsibility, Drexelbrook may decline to make further shipments except against cash payment or the grant of satisfactory collateral security for payment.

If Drexelbrook is not permitted to make shipment within six months by Customer request, escalation will apply. The escalated price will be the price in effect at time of shipment. If the increase in Drexelbrook price between order date and shipment date exceeds the increase on the Consumer Price Index for the same period, the price increase will be limited to the percentage increase in the index.

3. **EXPORT TERMS**: Irrevocable letter of credit or CAD (Cash Against Documents)

4. **WARRANTY**: Drexelbrook warrants the Equipment to be free from defects of material and workmanship under normal use and service conditions for a term of 365 days from the date of shipment. This warranty shall not apply to Equipment to which any modifications, alternations or attachments have been made without written authorization of Drexelbrook.

ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING WARRANTIES OF FITNESS FOR ANY PARTICULAR PURPOSE AND MERCHANTABILITY, ARE EXCLUDED BY AGREEMENT OF THE PARTIES. ALL USED EQUIPMENT IS SOLD "AS IS". UPON THE OCCURRENCE OF ANY DEFAULT BY CUSTOMER IN PAYMENT OF ANY PORTION OF THE PURCHASE PRICE OR ANY LEASE OR RENTAL PAYMENT WHEN DUE, OR ANY OTHER OBLIGATION, FOR SERVICE, PARTS, SUPPLIES OR ACCESSORIES WHEN DUE, ALL WARRANTIES SHALL THEREUPON TERMINATE AND ALL OBLIGATIONS OF DREXELBROOK TO SERVICE THE EQUIPMENT SHALL THEREUPON TERMINATE.

All Equipment returned for repair under warranty must be accompanied by:

(1) the original Drexelbrook purchase order number (or that of customer)

(2) the date or installation

(3) a written statement that the Equipment is being returned for repair under warranty

Drexelbrook equipment is built with great care, and subjected to rigorous quality control. Even so, failures of any equipment can and do occur. Sound engineering practice demands that whenever equipment failure may result in more than an inconvenience, a completely independent back up system be employed such that failure of either the unit or the backup unit will not permit the hazardous condition to occur.

(IT IS IMPORTANT THAT YOU READ REVERSE SIDE)

5. **LIMITS OF LIABILITY**: If Customer rightfully rejects the Equipment or justifiably revokes acceptance of the Equipment, Drexelbrook shall be liable only to repay any part of the purchase price theretofore paid, upon the return of the Equipment to it. After acceptance of the Equipment, if any part thereof is found to be defective, under specified service conditions within 365 days after shipment, and while the warranty under paragraph 4 hereof is in effect. Drexelbrook at its option will repair or replace such part f.o.b. its factory provided that the original part is returned to its factory, transportation prepaid, pursuant to shipping instructions from Drexelbrook and Drexelbrook's inspection establishes the claim. The foregoing constitutes Customer's sole and exclusive remedy for breach of the terms of sales of the Equipment. Drexelbrook shall in no event be liable for damage or delay caused by defective material or workmanship, and no allowance will be made for repairs or alterations unless made with its approval.

Drexelbrook shall in no event be liable for damages, including without limitation incidental or consequential damages, to any property or to any person, by reason of Drexelbrook's negligence or otherwise, in connection with the sale, delivery, installation or use of the Equipment, and Customer shall indemnify and hold harmless Drexelbrook against all such liability.

6. **OSHA REQUIREMENTS**: The statement in Drexelbrook data sheets numbered 440-1-38 and 440-1-39 specifies Drexelbrook's position with respect to OSHA compliance.

7. **SECURITY INTEREST**: Without reference to the form of invoice which may be used by Drexelbrook, a purchase money security interest in the Equipment shall remain in Drexelbrook as security until the purchase price (including any extensions of payment whether evidenced by note or otherwise) shall be fully paid. The Equipment shall remain personal property, whatever may be the mode of its attachment to realty or other property, until the purchase price shall be fully paid, and Customer shall perform all acts which may be necessary to perfect and assure retention of such security interest in Drexelbrook. If Customer fails to make any payment of or an account of the purchase price when due, Drexelbrook may at its option take exclusive possession of the Equipment wherever found and remove the Equipment without legal process, and Customer shall pay to Drexelbrook installation and removal costs plus a use charge equal to 4% of the purchase price per month, or fraction thereof, from the date of shipment, and any payments which have theretofore been made on account of the purchase price of the Equipment shall be retained by Drexelbrook and applied to such costs and charges, with any balance thereof being retained as liquidated damages, without prejudice to its right to recover any further damages which it may suffer from any cause.

8. **TAXES**: Customer shall pay all state, municipal or other sales, use, excise or other taxes, assessments, and charges assessed or levied against the Equipment and pay to Drexelbrook on request any state, municipal or other sales, use, excise or other taxes, assessments or charges payable to Drexelbrook with respect to the Equipment or the sale or use thereof.

9. **INSTALLATION**: Unless otherwise agreed, the Equipment will be installed by the Customer. Drexelbrook shall not be liable for any injury to persons or damage to property occurring in the course of or as a result of the presence of its agents or employees on Customer premises, with respect to installation or subsequent service.

10. **SPECIFICATIONS**: The Equipment delivered hereunder may vary in details of design, construction, arrangement or accessories from the description thereof in any descriptive or sales literature or from any display or other equipment of the same model which Customer has inspected. Drexelbrook reserves the right to make such changes in such details as, in its discretion, constitute improvements. Drexelbrook is not obligated to supply schematic or shop working drawings.

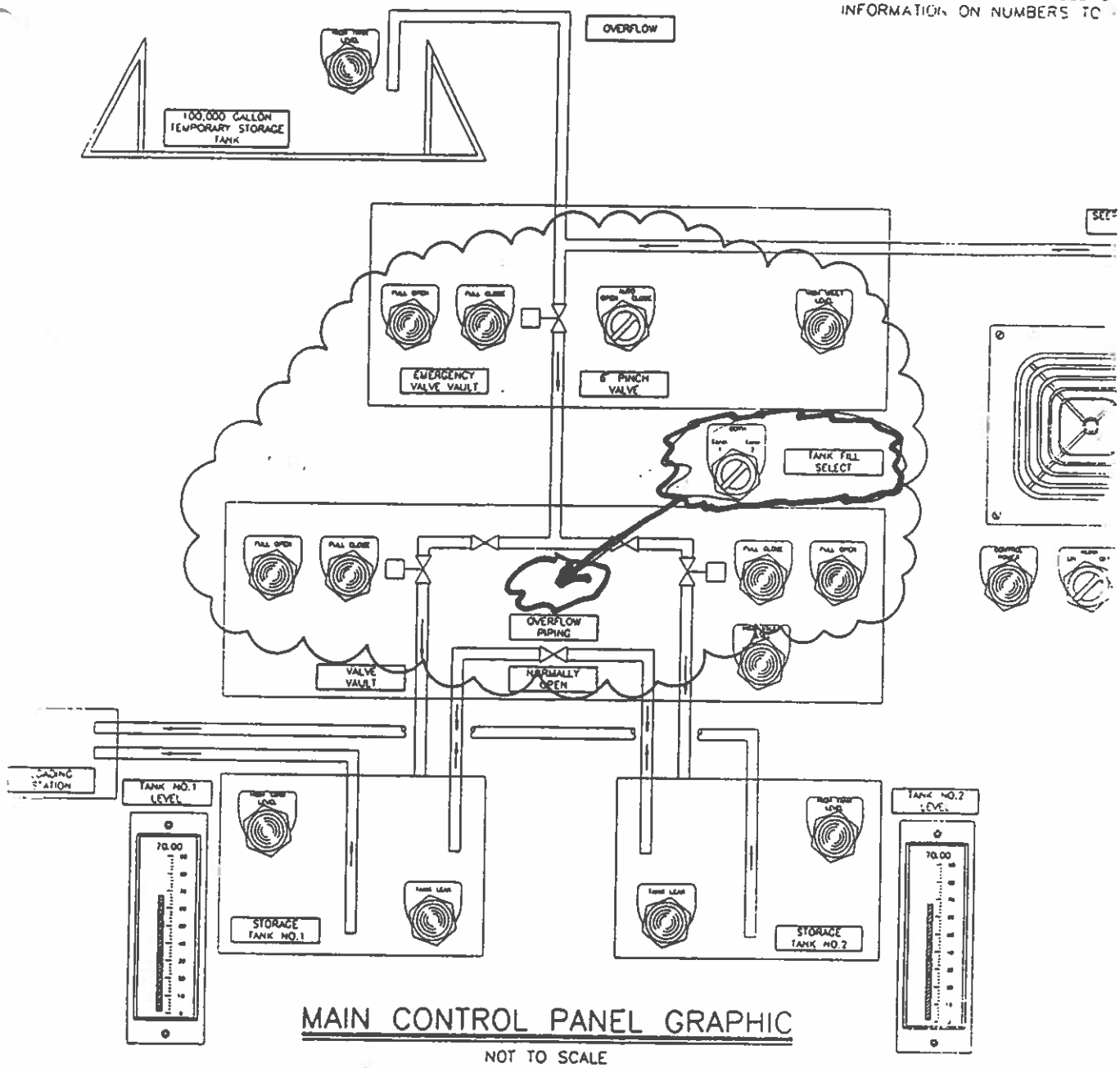
11. **ASSIGNMENT**: Neither this agreement nor any right granted hereby may be assigned by Customer voluntarily or by operation of law without Drexelbrook's prior written consent.

12. **GENERAL**: This order is the complete agreement between the parties and there are no other agreements or understandings changing or modifying the terms hereof, whether contained in any order form of Customer or otherwise. This agreement is entered into after full investigation without either party relying on any statement or representation made by the other party not embodied in this agreement. No waiver, change, amendment or discharge of any term or condition hereof or consent hereunder on the part of Drexelbrook shall be effective unless made in writing and signed by an authorized officer of Drexelbrook. This agreement has become effective upon the acceptance of Customer's order by Drexelbrook in Horsham, Pennsylvania, and the rights and duties of Drexelbrook and Customer, with respect to the sale (or lease or rental, as the case may be) delivery and installation of the Equipment shall be governed by these terms and conditions, and any related Lease or Rental Agreement, and the laws of the Commonwealth of Pennsylvania. Acceptance of this order by Drexelbrook is contingent upon (1) a satisfactory credit report on customer and (2) the absence of any mathematical error with regard to dollar amounts stated herein.

1 AUTODIALER SHALL BE RACK
8 CONTACT CHANNELS.
PROTECTION WITH 6 HOUR BA
PROVIDE CONNECTION TO MCP
SELECTOR. DIALER SHALL BE W
ALARM OUTPUTS SHOWN ELEME
INFORMATION ON NUMBERS TO

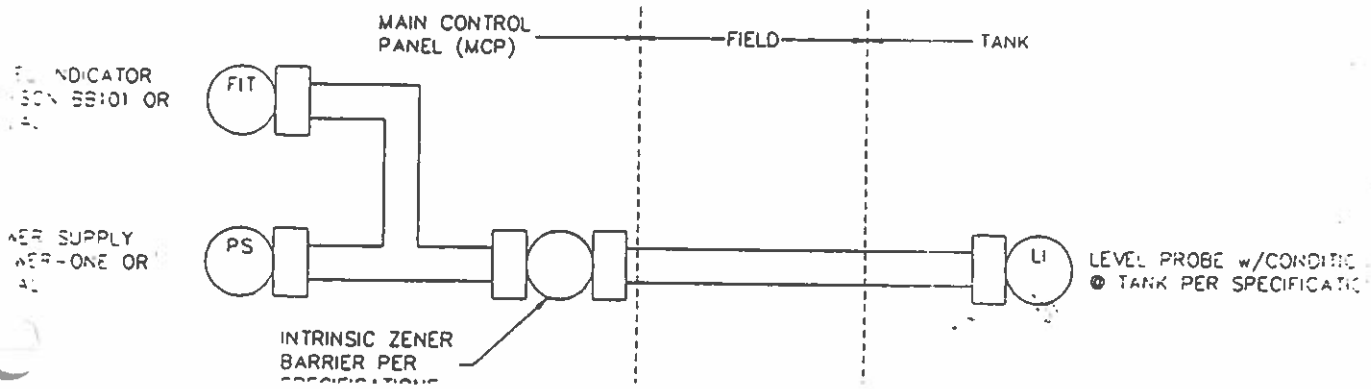
MAIN CONTROL PANEL

NOT. TO SCALE

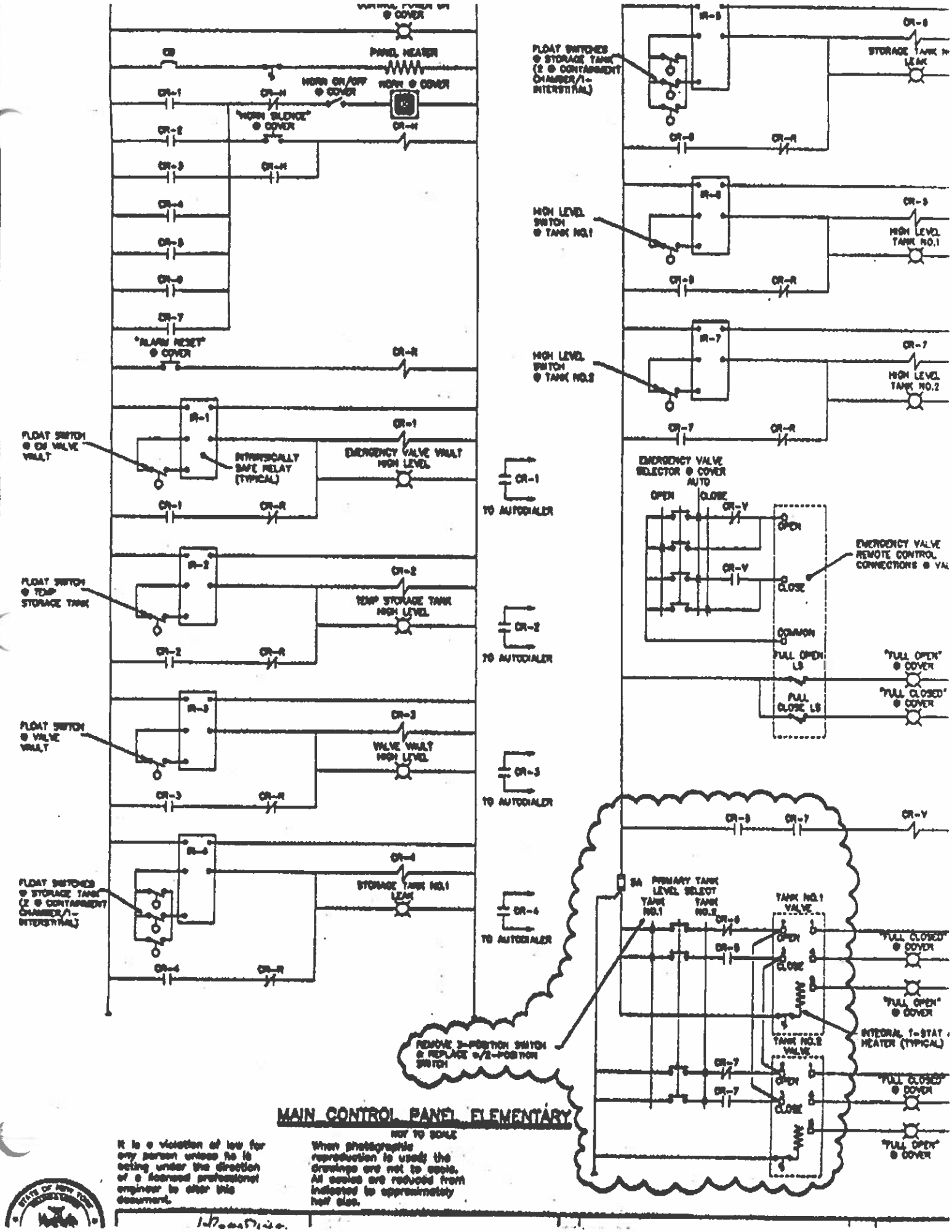


MAIN CONTROL PANEL GRAPHIC

NOT TO SCALE

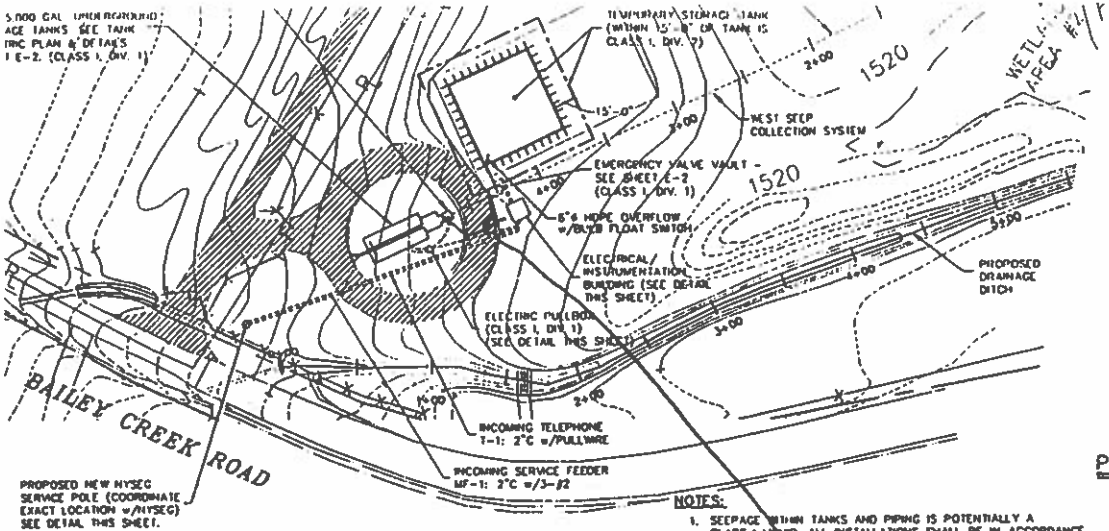


9401 Revised
9/27/94



MAIN CONTROL PANEL ELEMENTARY

NOT TO SCALE



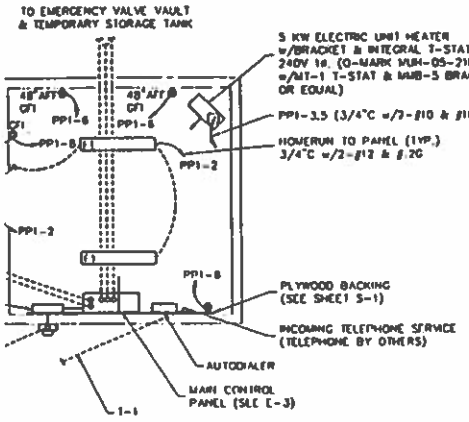
ELECTRIC SITE PLAN

SCALE: 1" = 50'-0"

NOTES:

1. SEEPAGE WITHIN TANKS AND PIPING IS POTENTIALLY A CLASS I LIQUID. ALL INSTALLATIONS SHALL BE IN ACCORDANCE WITH NFPA-30.
2. ALL WIRING WITHIN CLASSIFIED AREAS SHALL BE IN ACCORDANCE WITH NEC ARTICLES 500 THRU 504. WIRING SHALL BE INTRINSICALLY SAFE AND/OR EXPLOSION-PROOF. SEAL-OFF, FITTINGS, ETC. SHALL BE PROVIDED WHERE REQUIRED.

Added 1" RSC to Valve Vault
Tank Cir Valves



ONDUIT SHALL BE RIGID STEEL.

ONDUIT MAY BE EXPOSED.

IRING SHALL CONFORM w/NEC REQUIREMENTS
HAZARDOUS (CLASSIFIED AREAS).

/INSTRUMENTATION BLDG. PLAN

SCALE: 1/4"=1'-0"

PANEL SCHEDULE

PANELBOARD PP1 LOCATION ELECTRICAL/INSTRUMENTATION INSTALLATION SURFACE

RATINGS 100 AMPS, 120/240 VOLTS, 1 PH, 3 WIRE, 60 HZ, GRD BAR X

MAIN LUGS - AIR INTERRUPTING RATING - RMS SYMM. AMPS

MAIN CIRCUIT BREAKER 100 AMPS, CONNECTED LOAD - KW, PANEL SIZE 20 SPACES

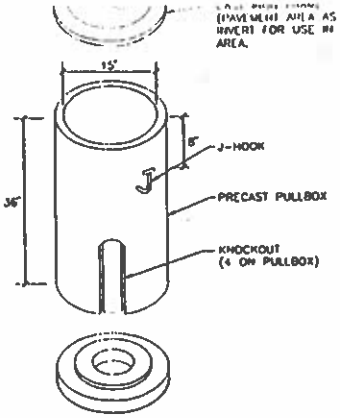
DESCRIPTION	LOAD in KW	PHASE AMPS	CKT	1	2	CKT	PHASE AMPS	LOAD in KW	DESCRIPTION
EMERGENCY BY-PASS VALVE	-	20	1			2	20	-	BUILDING LIGHTS
ELECTRIC UNIT HEATER	-	30 2P	3			4	20	-	MAIN CONTROL PANEL
			5			6	20	-	CONVENIENCE OUTLETS
SPARE	-	20 2P	7			8	20	-	EXTERIOR OUTLET
			9			10	20	-	AUTODIALER
SPACE	-	-	11			12	20	-	TANK LEAK/LEVEL MONITOR
			13			14	20	-	SPARE
			15			16			
			17			18			
			19			20			

PP1 SHALL BE WESTINGHOUSE B102020CT LOADCENTER w/SURFACE COVER OR EQUAL.

As Built Conduit Schedule

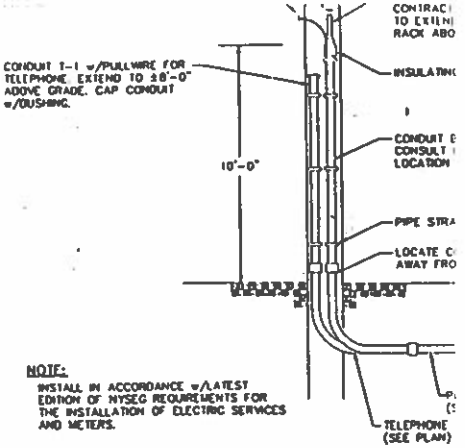
LIGHTING FIXTURE SCHEDULE

TYPE	DESCRIPTION	TYPICAL APPLICATION (FOR INFORMATION ONLY)	LAMPS QUANTITY	LAMPS TYPE	VOLTAGE	MANUFACTURER ID - MODEL	MANUFACTURER ID - MODEL	REMARKS
T-1	4' INDUSTRIAL FLUORESCENT FIXTURE	ELECTRICAL/INSTRUMENTATION BUILDING	2	F40	120	LITHONIA AFS1240/120/ES	MLP	COLD WEATHER BALLAST
MF-1	WALL-PAK TYPE EXTERIOR METAL HALIDE	ELECTRICAL/INSTRUMENTATION BUILDING EXTERIOR	1	175W MH	120	LITHONIA WM175M/120	MLP	w/PHOTOCELL



PRECAST ELECTRIC PULLBOX DETAIL

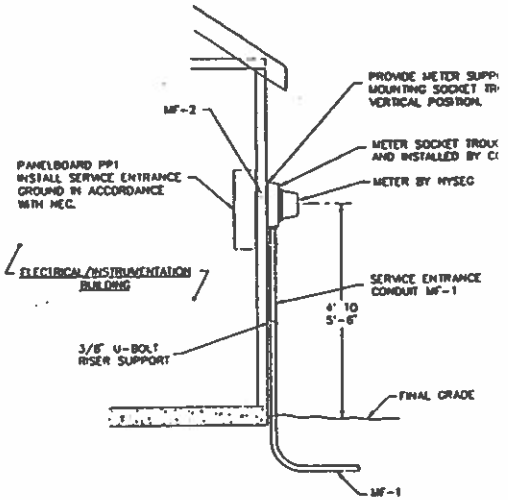
NOT TO SCALE



NOTE:
INSTALL IN ACCORDANCE w/LATEST EDITION OF NYSEG REQUIREMENTS FOR THE INSTALLATION OF ELECTRIC SERVICES AND METERS.

INCOMING SECONDARY SERVICE POL

NOT TO SCALE



INCOMING ELECTRIC SERVICE DETAIL

NOT TO SCALE

INSTALL IN ACCORDANCE w/NYSEG REQUIREMENTS

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When photographic reproduction is used; the drawings are not to scale. All scales are reduced from indicated to approximately half size.

1"=50' 0 50 100

checked by

O'BRIEN & GERE

EDWARD ALLEN LANDFILL
SITE REMEDIATION PROJECT

ELECTRICAL

PANEL SCHEDULE

PANELBOARD PP1 LOCATION ELECTRICAL/INSTRUMENTATION INSTALLATION SURFACE

RATINGS 100 AMPS, 120/240 VOLTS, 1 PH, 3 WIRE, 60 HZ., GRD BAR X

MAIN LUGS - BKR INTERRUPTING RATING - RMS. SYMM. AMPS

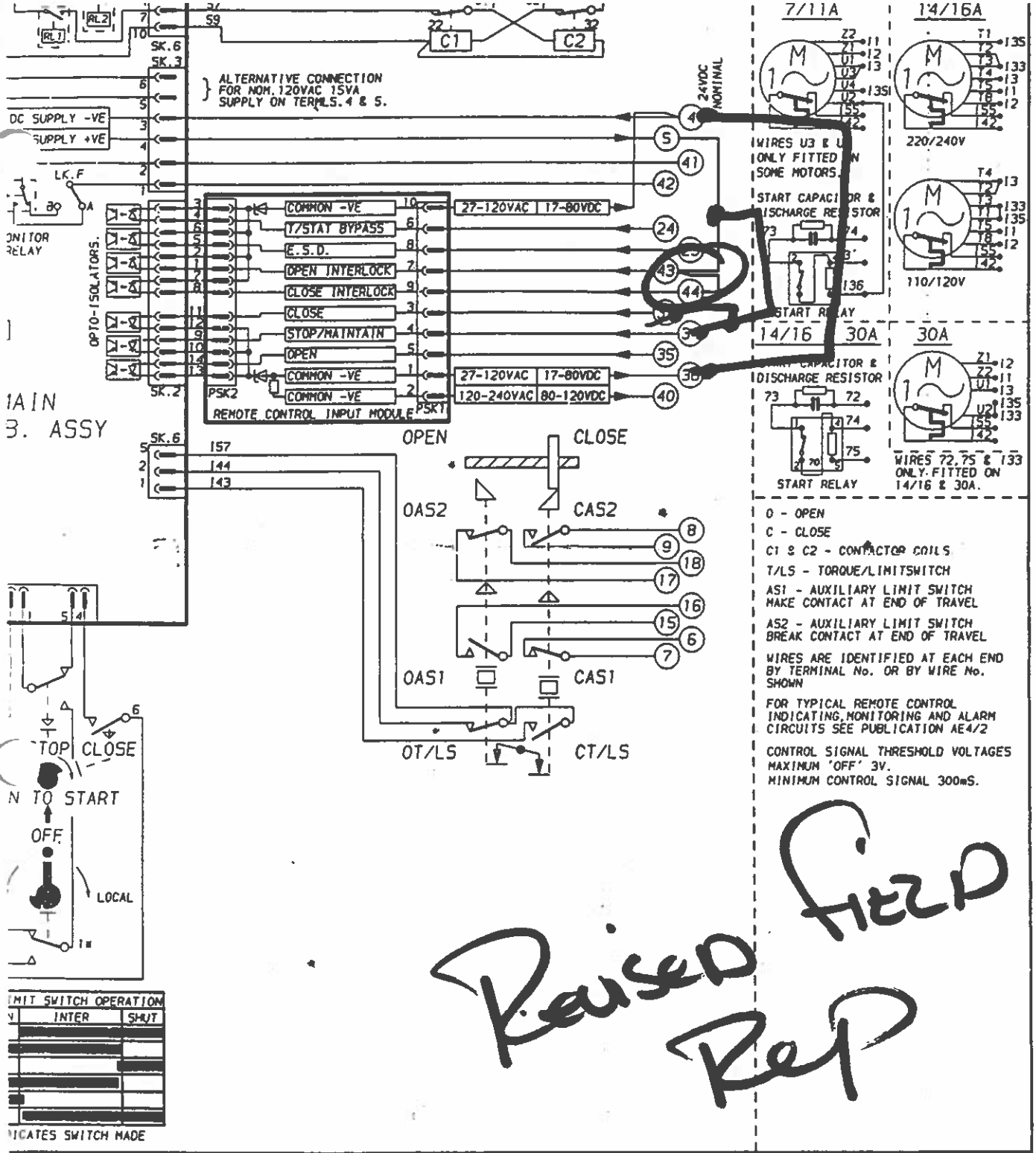
MAIN CIRCUIT BREAKER 100 AMPS, CONNECTED LOAD - KW, PANEL SIZE 20 SPACES

DESCRIPTION	LOAD W-KW-HP	BKR AMPS	CKT		CKT	BKR AMPS	LOAD W-KW-HP	DESCRIPTION
EMERGENCY BY-PASS VALVE	-	30	1	1 N 2	2	20	-	BUILDING LIGHTS
ELECTRIC UNIT HEATER	-	30/2P	3		4	20	-	MAIN CONTROL PANEL
			5		6	20	-	CONVENIENCE OUTLETS
SPARE		20/2P	7		8	20	-	EXTERIOR OUTLET
			9		10	20	-	AUTODIALER
SPACE			11		12	20	-	TANK LEAK/LEVEL MONITOR
			13		14	20	-	TANK FILL CONTROL VALVES
			15		16	20	-	SPARE
			17		18			
			19		20			

PP1 SHALL BE WESTINGHOUSE B102020CT LOADCENTER w/SURFACE COVER OR EQUAL.

LIGHTING FIXTURE SCHEDULE

SCRIPTION	TYPICAL APPLICATION (FOR INFORMATION ONLY)	LAMPS		VOLTAGE	MANUFACTURER #1 - M
		QUANTITY	TYPE		
NDUSTRIAL CENT FIXTURE	ELECTRICAL/INSTRUMENTATION BUILDING	2	F40 -	120	LITHONIA AFST240/120/ES
TYPE EXTERIOR AL HALIDE	ELECTRICAL/INSTRUMENTATION BUILDING EXTERIOR	1	175W MH	120	LITHONIA TWH175M/120



O - OPEN

C - CLOSE

C1 & C2 - CONTACTOR COILS

T/LS - TORQUE/LIMITSWITCH

AS1 - AUXILIARY LIMIT SWITCH MAKE CONTACT AT END OF TRAVEL

AS2 - AUXILIARY LIMIT SWITCH BREAK CONTACT AT END OF TRAVEL

WIRES ARE IDENTIFIED AT EACH END BY TERMINAL No. OR BY WIRE No. SHOWN

FOR TYPICAL REMOTE CONTROL INDICATING, MONITORING AND ALARM CIRCUITS SEE PUBLICATION AE4/2

CONTROL SIGNAL THRESHOLD VOLTAGES
MAXIMUM 'OFF' 3V.
MINIMUM CONTROL SIGNAL 300mS.

Revised Field Rep

REVISION
SIMILAR TO 9610A00
JOB No --
57/58 REVERSED FOR C1 = CLOSE
CHECKED K.S.

rotork

ROTORK CONTROLS LTD
BATH ENGLAND, BA1 3JQ.
tel (0225) 428451

ROTORK CONTROLS INC
ROCHESTER, NY 14624.
tel (716) 328-1550

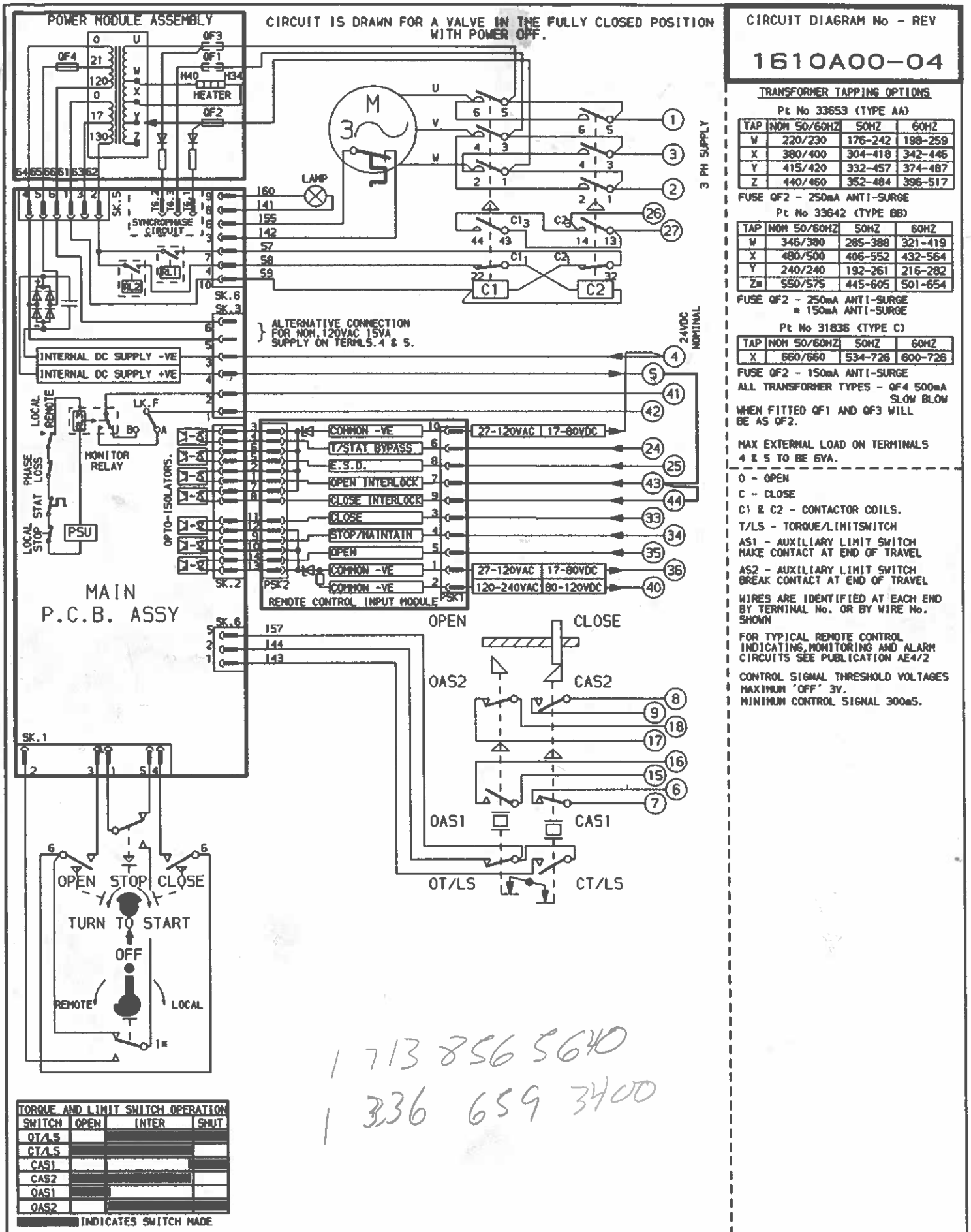
DRAWN J.R
DATE 110589

CHECKED K.S
DATE 110589

BASIC 1600 MK4 SINGLE PHASE
-

CIRCUIT DIAGRAM No -REV
9610A00-02

See Attached



CIRCUIT DIAGRAM No - REV

1610A00-04

TRANSFORMER TAPPING OPTIONS

Pt No 33653 (TYPE AA)

TAP	NOM 50/60HZ	50HZ	60HZ
W	220/230	176-242	198-259
X	380/400	304-418	342-446
Y	415/420	332-457	374-487
Z	440/460	352-484	396-517

FUSE QF2 - 250mA ANTI-SURGE

Pt No 33642 (TYPE BB)

TAP	NOM 50/60HZ	50HZ	60HZ
W	346/380	285-388	321-419
X	480/500	406-552	432-564
Y	240/240	192-261	216-282
Z	550/575	445-605	501-654

FUSE QF2 - 250mA ANTI-SURGE
≡ 150mA ANTI-SURGE

Pt No 31836 (TYPE C)

TAP	NOM 50/60HZ	50HZ	60HZ
X	660/660	534-726	600-726

FUSE QF2 - 150mA ANTI-SURGE

ALL TRANSFORMER TYPES - QF4 500mA SLOW BLOW

WHEN FITTED QF1 AND QF3 WILL BE AS QF2.

MAX EXTERNAL LOAD ON TERMINALS 4 & 5 TO BE 6VA.

O - OPEN

C - CLOSE

C1 & C2 - CONTACTOR COILS.

T/LS - TORQUE/LIMITSWITCH

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CONTROL SIGNAL THRESHOLD VOLTAGES
MAXIMUM 'OFF' 3V.
MINIMUM CONTROL SIGNAL 300mS.

TORQUE AND LIMIT SWITCH OPERATION

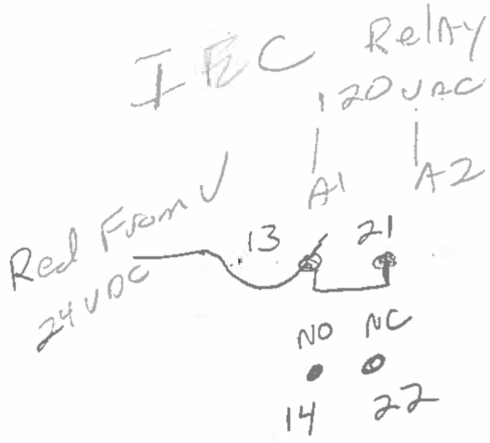
SWITCH	OPEN	INTER	SHUT
OT/LS			
CT/LS			
CAS1			
CAS2			
OAS1			
OAS2			

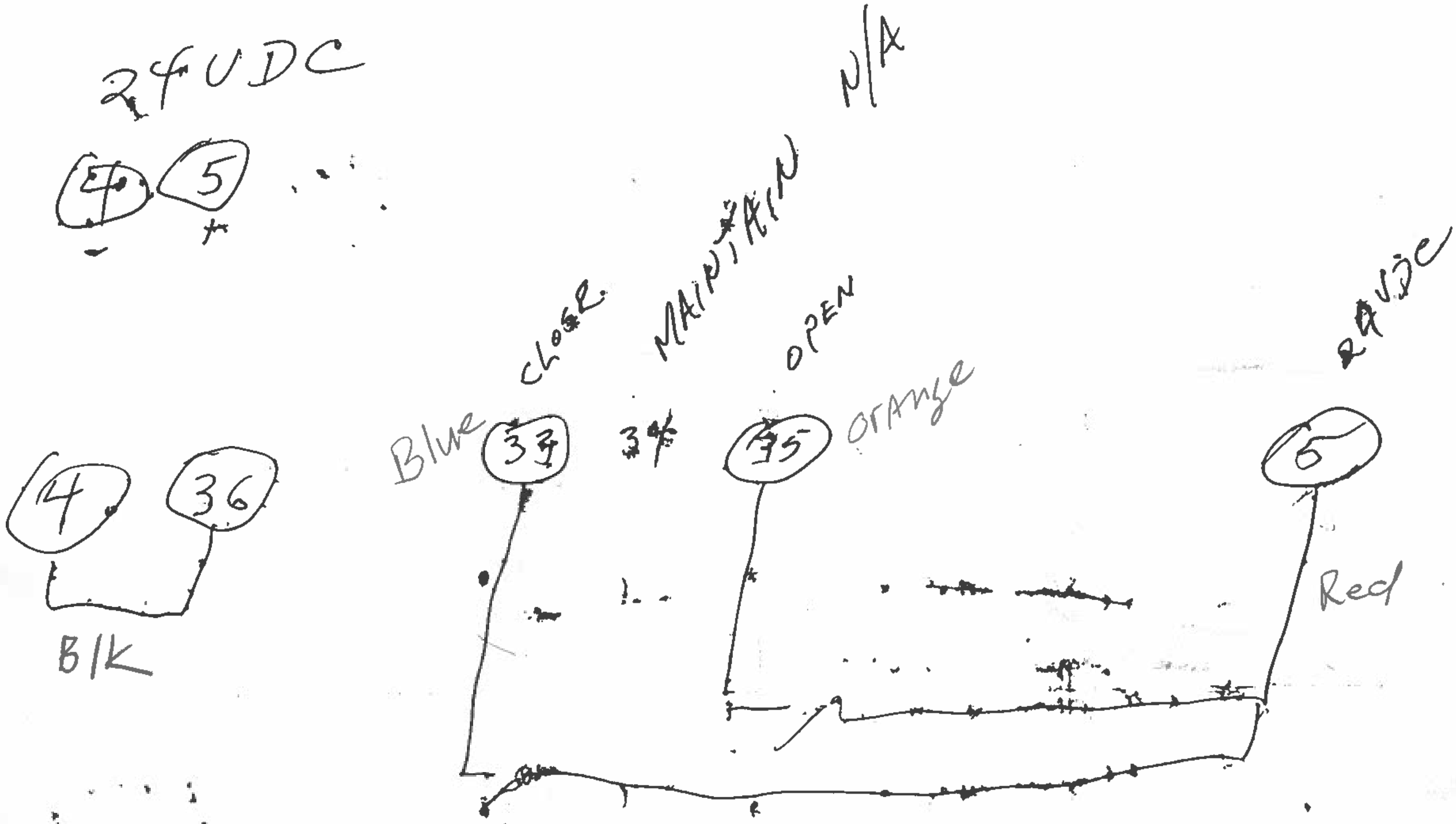
INDICATES SWITCH MADE

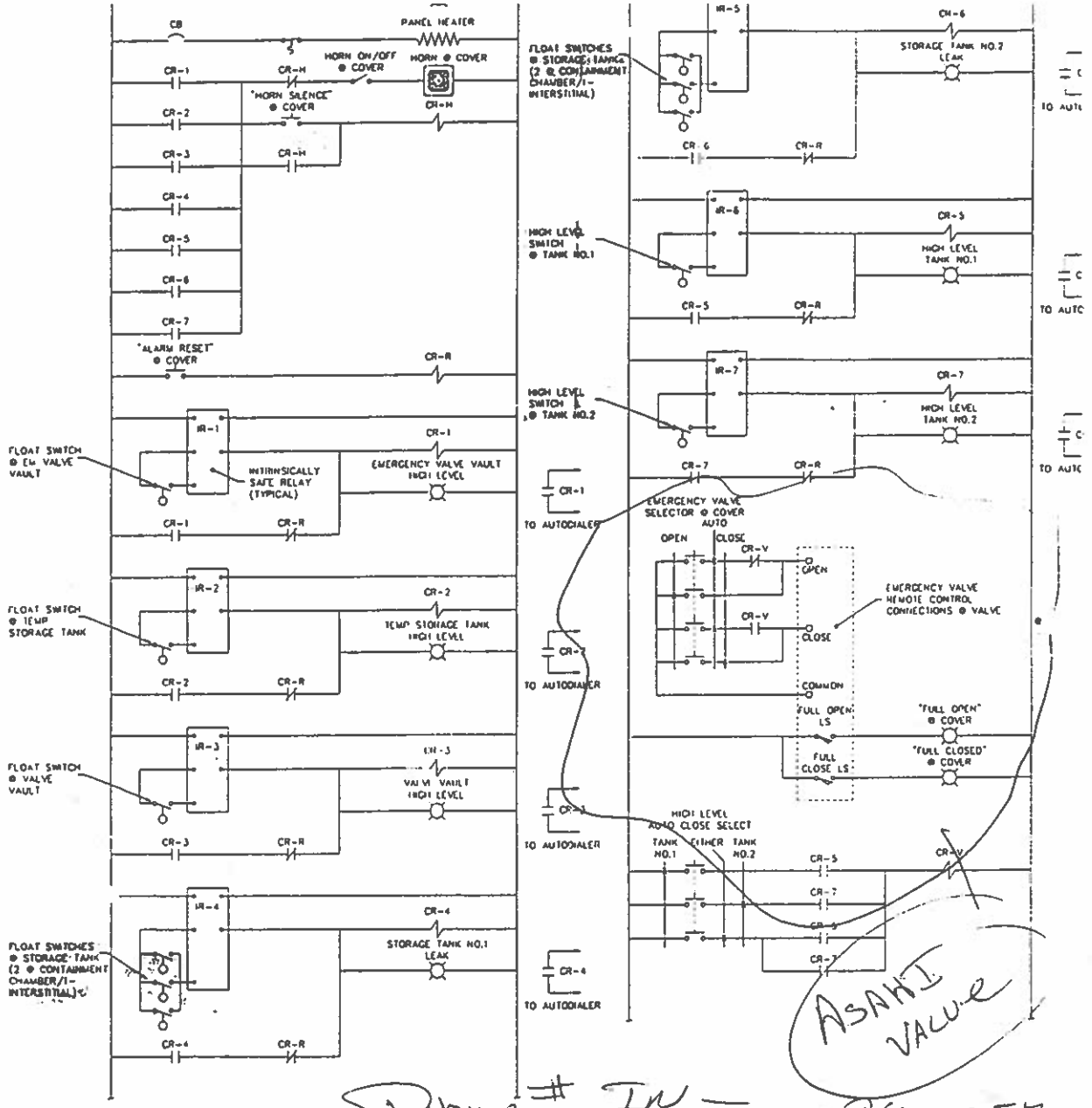
1 713 856 5640
1 336 659 3400

No	DATE	REVISION	ROTORK CONTROLS LTD BATH ENGLAND, BA1 3JQ. tel (0225) 428451	DRAWN	K.S	BASIC 1600 MK4.
04		SIMILAR TO 1610A00 JOB No —		DATE	310787	-

Control diagram [illegible]
for changes
[illegible]
2-21-95
from Factory Man[illegible]







Prowe # IN — 962 1257

MAIN CONTROL PANEL ELEMENTARY

NOT TO SCALE

It is a violation of law for any person unless he is acting under the direction of a licensed professional engineer to alter this document.

When photographic reproduction is used, the drawings are not to scale. All scales are reduced from indicated to approximately half size.

OUT PRI # 607-974-6911

OUT Sec # 607-974-8407

In charge of

Designed by PO Checked by

O'BRIE

1 Black = Common

2 White = Open SW

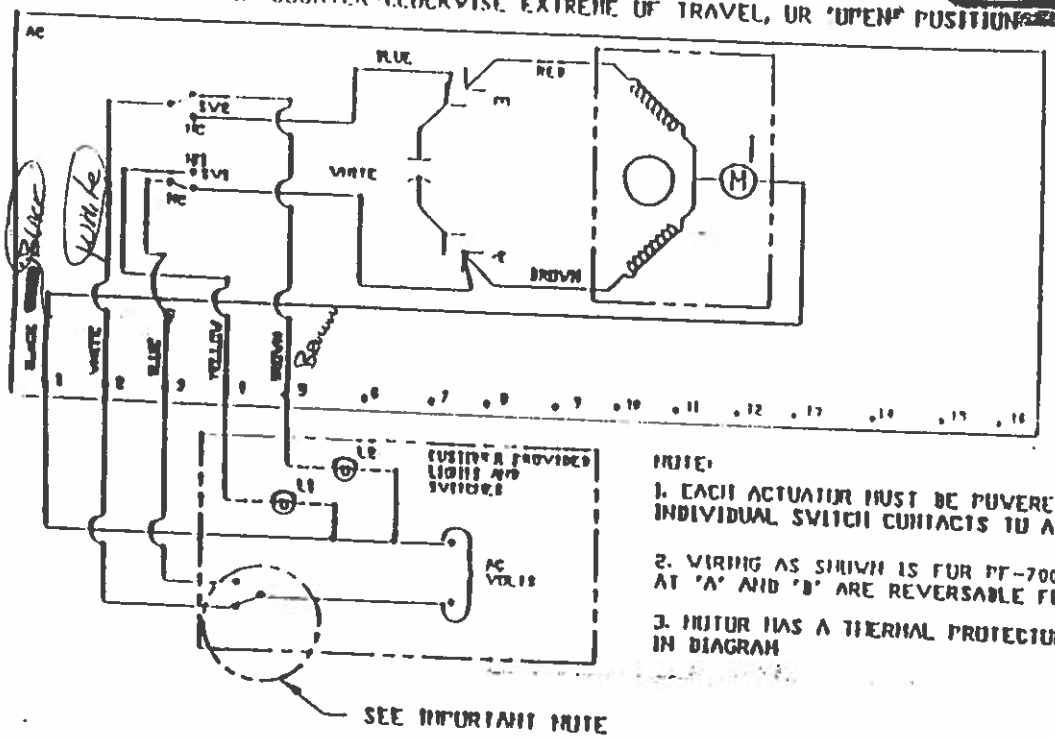
3 Blue = Close SW

4 Yellow = Close Light

5 Brown = Opened Light

AC WIRING DIAGRAM

ACTUATOR SHOWN IN COUNTER-CLOCKWISE EXTREME OF TRAVEL, OR "OPEN" POSITION



NOTE:

1. EACH ACTUATOR MUST BE POWERED THRU ITS OWN INDIVIDUAL SWITCH CONTACTS TO AVOID CROSS FEED

2. WIRING AS SHOWN IS FOR PF-700 MOTOR LEADS AT "A" AND "B" ARE REVERSABLE FOR PF-1100

3. MOTOR HAS A THERMAL PROTECTOR AS SHOWN BY (M) IN DIAGRAM

	NAME	DATE
DR	RJ	11/15/93
CHK		
APP'D		
FILE	S92\WIRING	

ASAHI/AMERICA

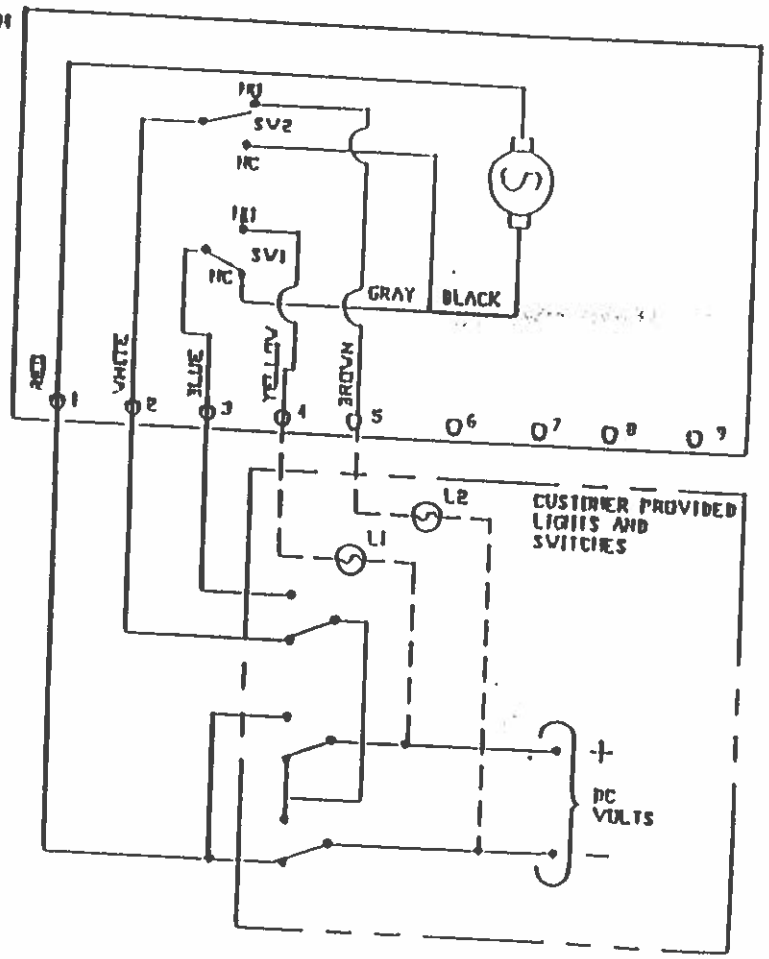
10 GREEN STREET, P.O. BOX 651 HALDEN, MA

QUARTER MASTER CHIEF
AC WIRING DIAGRAM

SIZE	DWG. NO.	REV
A	006S92	A

SCALE

DC WIRING DIAGRAM



ACTUATOR SHOWN IN COUNTER CLOCKWISE EXTREME OF TRAVEL OR "OPEN" POSITION

1	2	3	
-	+		= OPEN
+		-	= CLOSE

DRAWING TO BE PRINTED ON 3X6 LABEL

	NAME	DATE
DR	MJ	10/12/93
CHK		
APPD		
FILE	S92	

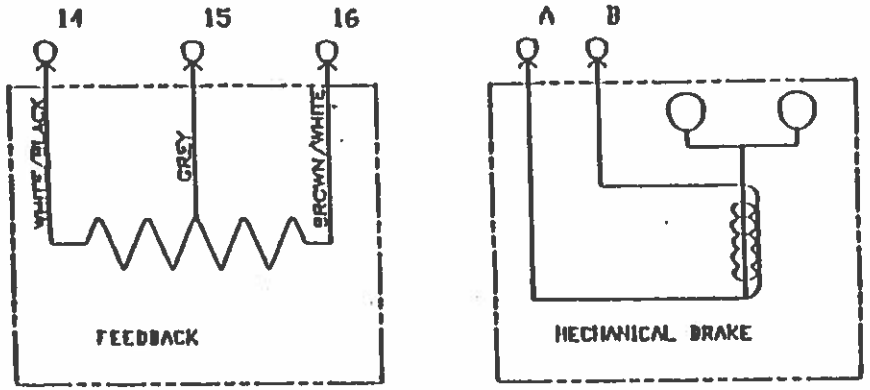
ASAHI/AMERICA

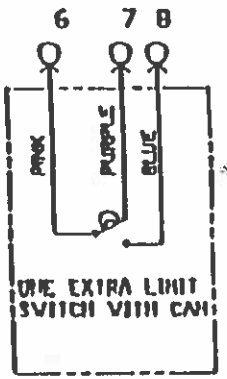
19 GREEN STREET, P.O. BOX 653, MALDEN, MA.

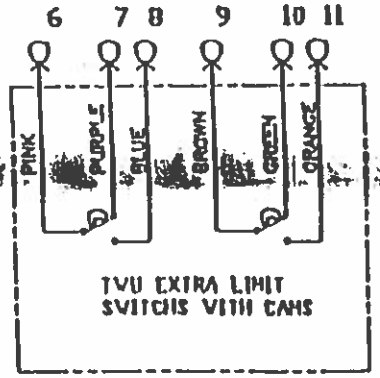
QUARTER MASTER CHIEF
DC WIRING DIAGRAM

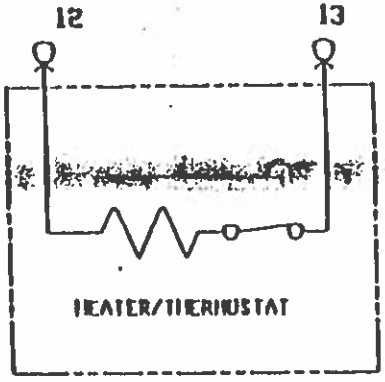
SIZE	DWG. NO.	REV
	01792DC	

SCALE ....









	NAME	DATE
DR	VH	4/11/94
CHK		
APPD		
FILE	S92\083S92	

ASAHI/AMERICA
19 GREEN STREET, P.O. BOX 653, MALDEN, MA

QUARTER MASTER CHIEF OPTIONS WIRING DIAGRAM

SIZE	DWG. NO.	REV
A	083S92	
SCALE 1	SHEET 1 OF 1	

GRIFFITH ELECTRICAL CONTROL SYSTEMS INC.
(607) 648-9059

EDWARD ALLEN LANDFILL SITE REMEDIATION PROJECT

MAIN CONTROL PANEL TESTING

INTRODUCTION

TESTING AND VERIFICATION OF EQUIPMENT ARE TO BE PERFORMED ON ALL DIGITAL AND ANALOG INPUTS AND OUTPUTS , USING BOTH THE OPERATOR INTERFACE PANEL AND FIELD CONNECTED DEVICES FOR THESE OPERATIONAL TESTS.

DIGITAL INPUTS : FIELD TEST SHALL BE PREFORMED BY ACTUATION OF FIELD INPUT DEVICES OR USING FUNCTION BUTTONS ON THE PANEL CREATING A REAL WORLD CONTACT INPUT OR THRU THE JUMPERING OF TERMINAL BLOCKS BY FORCEING THE INPUT BIT TO THE TRUE STATE. VISUALLY VERIFY THE INPUT IS LIGHTED. VISUALLY CHECK STATUS INDICATORS AND OR PUSHBUTTON OPERATORS.

DIGITAL OUTPUTS : FIELD TESTS SHALL BE PERFORMED BY ACTUATION OF OUTPUT LOGIC OR BY FORCING THE OUTPUT BIT TO THE ENEGERIZED STATE. VISUALLY VERIFY THE OUTPUT LED ON THE PANEL IS LIGHTED AND THE FIELD CONNECTED DEVICE OR DEVICES ARE ENEGERIZED BY TOGGLEING ON/OFF.

ANALOG INPUTS : FIELD TESTS SHALL BE PERFORMED BY VIEWING THE PANEL SCREEN AT 0%,25%,50%,75%,AND 100% INPUT
VALUES. ASSOCIATED INTERNAL SCALING THAT CREATES SETPOINT OUTPUTS AND OR DIGITAL OUTPUTS WILL BE CHECKED FOR CORRECT ACUATION AND OPERATION.

ALARM MESSAGES: FIELD TESTS SHALL BE PERFORMED BY LISTENING TO THE DIALER MESSAGE BY TRIPPING THOSE SEQUENCES AND OR SETPOINTS TO SIMULATE ALARM CONDITIONS.

GRIFFITH ELECTRICAL CONTROL SYSTEMS INC.
491 CONKLIN HILL ROAD
CHENANGO FORKS, NEW YORK 13746

EDWARD ALLEN LANDFILL OBG TECHNICAL SERVICES

I/O TYPE	ADDRESS	DEVICE DESCRIPTION	% OF SPAN	SIMULATED INPUT	EXPECTED OUTPUT	AS FOUND OUTPUT	%OF ERROR	CALIBRATED OUTPUT	CORRECT DISPLAY	TODAYS DATE	TESTERS SIGNATURE
DI	IR-1	EM VALVE VAULT FLOAT SW	100 %	CLOSED	ON		%		YES/NO	2/16/95	DT
			0%	OPEN	OFF		%		YES/NO		
DI	IR-2	TEMP STORAGE TANK FLOAT SWITCH	100 %	CLOSED	ON		%		YES/NO		
			0 %	OPEN	OFF		%		YES/NO		
DI	IR-3	VALVE VAULT FLOAT SWITCH	100 %	CLOSED	ON		%		YES/NO		
			0 %	OPEN	OFF		%		YES/NO		
DI	IR-4	TANK 2 CONTAINMENT FLOAT SWITCHES	100%	CLOSED	ON		%	3/16	YES/NO	2/16/95	3/16/95 Replaced
			0 %	OPEN	OFF		%		YES/NO	2/16/95	3/16/95 Tested DT
DI	IR-5	TANK 1 CONTAINMENT FLOAT SWITCHES	100 %	CLOSED	ON		%		YES/NO		
			0 %	OPENED	OFF		%		YES/NO		
DI	IR-6	TANK1 HIGH LEVEL FLOAT SWITCH	100 %	CLOSED	ON		%		YES/NO		
			0%	OPENED	OFF		%		YES/NO		
DI	IR-7	TANK2 HIGH LEVEL FLOAT SWITCH	100%	CLOSED	ON		%		YES/NO		
			0%	OPENED	OFF		%		YES/NO		
DI	EV-S3	EMERGENCY VALVE SELECTOR SWITCH	RIGHT	CLOSED	OFF		%		YES/NO	VALVE WAS FROZEN 2/17/95 THAWED & RETESTED	
			CENTER	AUTO	CR-V		%		YES/NO		
			LEFT	OPENED	ON		%		YES/NO		
DI	TS-1/2	HIGH LEVEL SELECT TANK #1 OR #2	RIGHT	TANK #2	CR-7		%		YES/NO		
			CENTER	EITHER 1/2	CR-5/7		%		YES/NO		
			LEFT	TANK #1	CR-5		%		YES/NO		
DI	HS	HORN ON/OFF SELECTOR SWITCH	RIGHT	OFF	OFF		%		YES/NO		
			LEFT	ON	ON		%		YES/NO	2/16/95	D.T.

--- REMARKS OR COMMENTS ---

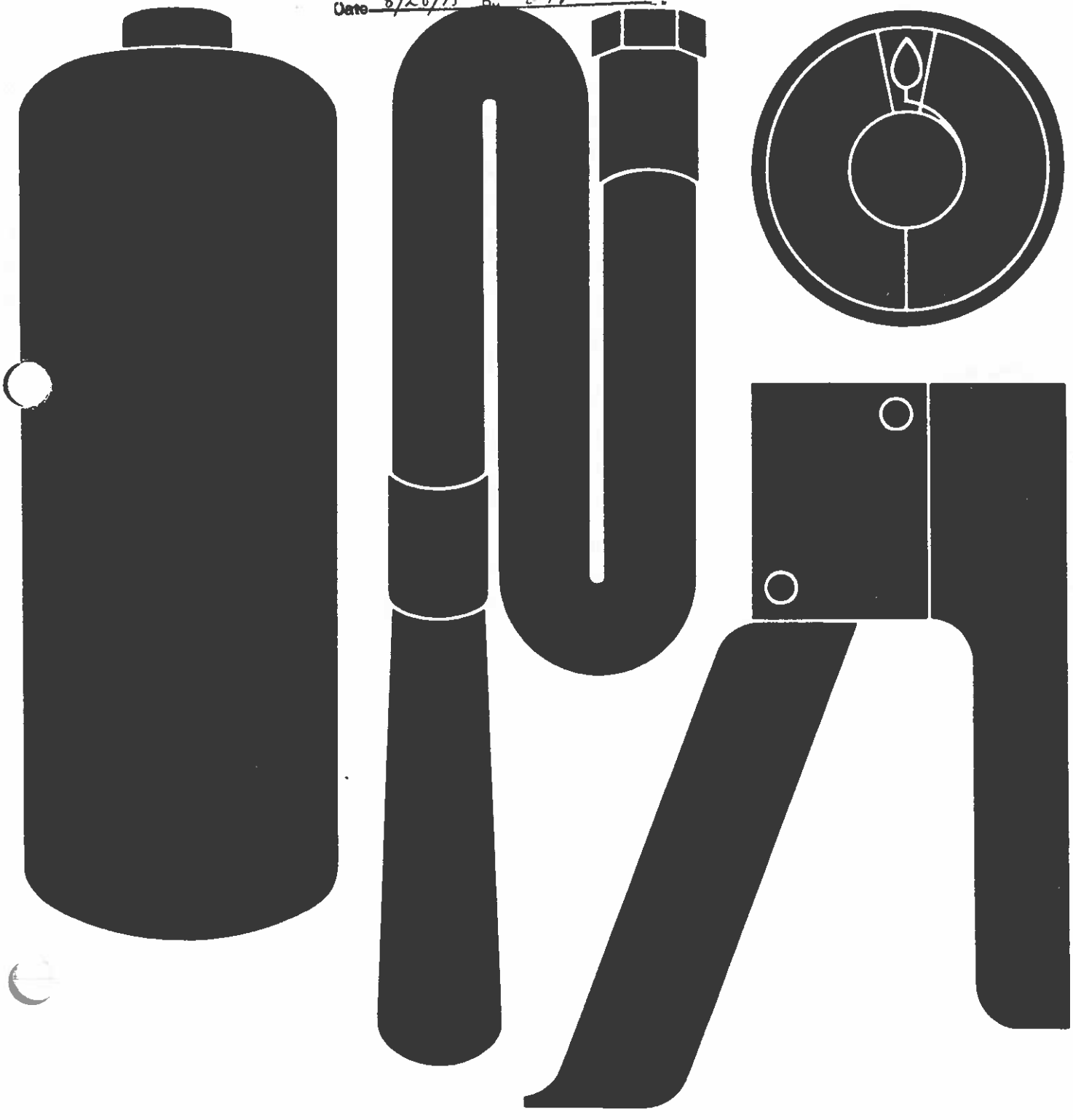
I/O TYPE	PLC ADDRESS	DEVICE DESCRIPTION	% OF SPAN	SIMULATED INPUT	EXPECTED RESULT	AS FOUND OUTPUT	% OF ERROR	CALIBRATED OUTPUT	PLC DISPLAY	TODAYS DATE	TESTERS SIGNATURE
D/O	CR-1	EMERGENCY VALVE VAULT HIGH LEVEL TO AUTO DIALER	100 %	CLOSED	ON		%		YES/NO	2/16/95	D.T.
			0%	OPENED	OFF		%		YES/NO		
D/O	CR-2	TEMP STORAGE TANK HIGH LEVEL TO AUTO DIALER	100 %	CLOSED	ON		%		YES/NO	2/16/95	
			0%	OPENED	OFF		%		YES/NO		
D/O	CR-3	VALVE VAULT HIGH LEVEL TO AUTO DIALER	100%	CLOSED	ON		%		YES/NO	2/16/95	
			0 %	OPENED	OFF		%		YES/NO		
D/O	CR-4	STORAGE TANK #1 LEAK DECTED TO AUTO DIALER	100 %	CLOSED	ON		%		YES/NO	2/16/95	
			0 %	OPENED	OFF		%		YES/NO		
D/O	CR-6	STORAGE TANK #2 LEAK DECTED TO AUTO DIALER	100 %	CLOSED	ON		%		YES/NO	2/16/95	
			0 %	OPENED	OFF		%		YES/NO		
D/O	CR-5	HIGH LEVEL TANK #1 TO AUTO DIALER	100 %	CLOSED	ON		%		YES/NO		
			0 %	OPENED	OFF		%		YES/NO		
D/O	CR-7	HIGH LEVEL TANK #2 TO AUTO DIALER	100 %	CLOSED	ON		%		YES/NO	2/16/95	
			0 %	OPENED	OFF		%		YES/NO		
										2/16	D.T.

			0%	OFF	HORN OFF	OFF	YES/NO	2/16/95	D.T.
D/O	LT-1	POWER LIGHT	PTT	ON	ON	ON	YES/NO		[illegible]
D/O	FO-EM LT	EMERGENCY VALVE							
		FULL OPEN	100%	ON	ON	ON	YES/NO	2/16/95	
		FULL CLOSED	0%	ON	ON	ON	YES/NO		
D/O	T-1 LT	TANK#1 VALVE							
		FULL OPENED	100%	ON	ON	ON	YES/NO	2/16/95	
		FULL CLOSED	0%	ON	ON	ON	YES/NO		
D/O	T-1 LT	TANK#2 VALVE							
		FULL OPENED	100%	ON	ON	ON	YES/NO	2/16/95	
		FULL CLOSED	0%	ON	ON	ON	YES/NO		
A/I	LT-1	TANK #1 LEVEL TRANSMITTER	0%	0%	0 GAL	Calibrated 2/17/95	YES/NO		
			50%	50%	7500 GAL		YES/NO	→ need calibration/CEG Tech	
			100%	100%	15000 GAL		YES/NO		
A/I	LT-2	TANK#2 LEVEL TRANSMITTER	0%	0%	0 GAL	Calibrated 2/17/95	YES/NO		
			50%	50%	7500 GAL		YES/NO	→ need	D.T.
			100%	100%	1500 GAL		YES/NO		

ANSUL®

OPERATION RECHARGE, INSPECTION AND MAINTENANCE MANUAL

SENTRY® DRY CHEMICAL AND HALON 1211 HAND PORTABLE FIRE EXTINGUISHERS



This manual is intended for use with SENTRY Dry Chemical and Halon 1211 Hand Portable Fire Extinguishers.

Those who may operate, recharge, inspect, or maintain these fire extinguishers should read this entire manual. Specific sections will be of particular interest depending upon one's responsibilities.

Fire extinguishers are mechanical devices. They require periodic care. If the extinguishers are not installed properly, are abused in service or are not properly maintained, they may not perform reliably.

These extinguishers are pressure vessels that must be treated with respect and handled with care.

It is Ansul's recommendation that only genuine Ansul-supplied replacement components be installed on Ansul products. Ansul also recommends that only authorized Ansul distributors, who are trained in and authorized for a particular product line, be allowed to service and maintain Ansul products.

⚠ WARNING

Halon 1211, when applied to fire or to heated surfaces above 900 °F (482 °C), can produce toxic by-products. These by-products resulting from the decomposition of Halon 1211 have a sharp irritating odor. The by-products are principally halogen acids, free halogens and carbonyl halides. These decomposition by-products, even in low conentrations, are dangerous and in sufficient concentrations may result in personal injury or death. The quantity of these by-products that may be generated depends on the size of the fire, the concentration of Halon 1211, and the length of time the halon is in contact with the fire or heated surface. If these irritating odors are detected, evacuate the area immediately.

In addition, inhalation of concentrations of the Halon 1211 agent itself of three to four percent by volume for one minute may cause dizziness and tingling of the extremities. At concentrations of four to five percent by volume, effects such as dizziness, impaired coordination and reduced mental acuity become more definite with exposure of from one to two minutes duration. At concentrations of greater than five percent, in addition to the above symptoms, there is a risk of unconsciousness and possible death if the exposure is prolonged. It is difficult for the human senses to detect the presence of Halon 1211 or the concentration level, since Halon 1211 is a colorless gas with a very faint odor. The effects of exposure to Halon 1211 should disappear quickly upon removal from exposure.

Avoid inhalation of toxic by-products or concentrations of halon 1211 by evacuating and ventilating the area. Where Halon 1211 has been released in a confined space, prohibit smoking and use of electric and gas heaters and furnaces in the immediate area until the space has been completely ventilated.

Do not use the Halon 1211 extinguisher in confined spaces less than the applicable volume per extinguiser indicated below. If part of the confined space is occupied by equipment or other objects, this should be taken into account when calculating volume. The following calculations are based on a concentration of 2% of Halon 1211.

Halon 1211 Extinguisher Capacity		Minimum Net Room Volume Required for 2% Halon 1211 Concentration	
lb.	(kg)	$ft.^3$	(m^3)
2.5	(1.1)	312	(8.8)
5.0	(2.3)	624	(17.7)
9.0	(4.1)	1122	(31.8)
14.0	(6.4)	1746	(49.4)
17.0	(7.7)	2120	(60.0)

For further information, refer to Ansul Technical Bulletin No. 47.

In the event a person is overexposed to the agent, or exposed to toxic by-products, the person must be removed from exposure and given fresh air; summon medical assistance immediately.

FOREWORD

The Occupational Safety and Health Administration (OSHA) – Rules and Regulations state that "the National Fire Protection Association (NFPA) provides excellent guidelines in its standard for portable fire extinguishers." NFPA Pamphlet 10 – "Portable Fire Extinguishers" is available from the National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

RESPONSIBILITY

The owner or occupant of a property in which fire extinguishers are located has an obligation for the care and use of these extinguishers at all times. By doing so, he/she is contributing to the protection of life and property. The nameplates and instruction manual should be read and thoroughly understood by all persons who may be expected to use these extinguishers.

RECHARGE

All extinguishers shall be recharged immediately after use. They shall also be recharged when dictated by an inspection or when performing maintenance. Recharge is the replacement or replenishment of the extinguishing agent. It also includes the replenishment of the expellant for certain types of extinguishers. When performing the recharge, use only those materials specified on the nameplate. The use of other recharging materials may impair the efficiency, cause malfunction, or damage the extinguisher resulting in possible injury to the operator.

INSPECTION

"Inspection" is a "quick check" that an extinguisher is available and will operate. It is intended to give reasonable assurance that the extinguisher is fully charged and operable. This is done by seeing that it is in its designated place, that it has not been actuated or tampered with, and that there is no obvious physical damage or condition to prevent operation. The value of an inspection lies in the frequency, regularity, and thoroughness with which it is conducted. Extinguishers shall be inspected at regular monthly intervals, or at more frequent intervals when circumstances require.

MAINTENANCE

Extinguishers shall be maintained at regular intervals, not more than one year apart, or when specifically indicated by an inspection. Maintenance is a "thorough check" of the extinguisher. It is intended to give maximum assurance that an extinguisher will operate effectively and safely. It includes a thorough examination and any necessary repair, recharging, or replacement. It will normally reveal if there is a need for hydrostatic testing of an extinguisher.

Extinguishers removed for maintenance or recharge shall be replaced by spare extinguishers of the same type and at least equal rating.

Halon 1211 has been classified under the Montreal Protocol as an ozone depleting chemical. Its release into the atmosphere for any reason other than fire extinguishment MUST be minimized. For this reason, an appropriate Halon recovery system should be used when discharging Halon for servicing.

SIX YEAR TEARDOWN

NFPA 10, 1988 Edition, 4-4.1.3: Every six years, stored pressure extinguishers that require a 12-year hydrostatic test shall be emptied and subjected to the applicable maintenance procedures. When the applicable maintenance procedures are performed during periodic recharging or hydrostatic testing, the six-year requirement shall begin from that date.

The six year teardown constitutes a complete maintenance of the extinguisher shell, component parts and agent. An extinguisher recharge and maintenance, as described by this manual, also meets the six year teardown requirement.

NOTICE

At the six year teardown, SENTRY Halon 1211 extinguishers require replacement of the valve stem assembly and valve body quad ring. Lightly lubricate new valve stem O-ring and valve body quad ring with Silicone Grease (Part No. 9030). Do not lubricate valve stem seat.

⚠CAUTION

Examine interior of Halon agent tank for pitting or corrosion. If found, it indicates that excessive moisture has been introduced into the shell. Mark shell "REJECTED" and return to owner without recharging. Shell is to be properly destroyed to prevent reuse.

HYDROTEST

Extinguishers shall be hydrostatically tested at regular intervals as required in the NFPA Pamphlet 10 – "Portable Fire Extinguishers," or more frequently when inspection or maintenance indicates a specific need. Such tests are required on extinguisher shells.

IF, AT ANY TIME, AN EXTINGUISHER SHOWS EVIDENCE OF CORROSION OR MECHANICAL DAMAGE, IT SHALL BE SUBJECTED TO A HYDROSTATIC PRESSURE TEST, OR REPLACED.

⚠WARNING

Air or gas should not be used for pressure testing as failure of the shell could be violent and dangerous.

THE EXTINGUISHER SHALL BE DISCHARGED AND HYDROTESTED AT TWELVE YEAR INTERVALS IN ACCORDANCE WITH THE APPROPRIATE PROCEDURES. The periodic hydrostatic retest may be conducted within twelve months of the specified interval. Refer to Ansul Portable and Wheeled Fire Extinguisher Hydrostatic Test Instructions, Form No. F-7602.

RECORD KEEPING

Each extinguisher shall have a tag or label securely attached that indicates the month and year the maintenance was performed and shall identify the person performing the service. The same record tag or label shall indicate if recharging was also performed. The tag shall not be placed on the front of the extinguisher where it could obscure operating instructions. At least monthly, the date the inspection was performed and the initials of the person performing the inspection shall be recorded.

A separate label shall also be affixed to the extinguisher following a successful hydrostatic test. This label shall include the month and year the test was performed, the test pressure used, and the name or initials of the person performing the test. This label shall be self-destructive when removal from the extinguisher is attempted, and shall not be placed on the front of the extinguisher where it could obscure operating instructions.

In addition to the required tags or labels, a permanent file record should be kept for each extinguisher. This file record should include the date and the name of the person and/or agency performing maintenance, recharge or hydrostatic test. A description of dents remaining after passing a hydrostatic test should also be noted in this record.

PARTS LISTS

To order parts lists, contact Marketing Services, Ansul Fire Protection, Marinette, WI 54143-2542.

Parts of above were taken from NFPA Pamphlet 10.

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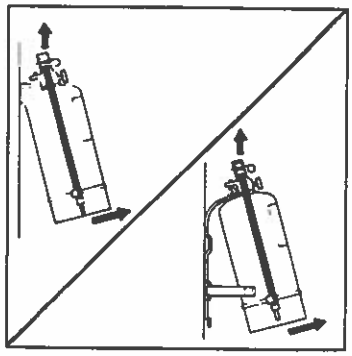
To Operate The Extinguisher:

1. Remove the extinguisher from its station.
2. Use the handle to carry the extinguisher to the fire. Walk at a rapid pace. DO NOT RUN.



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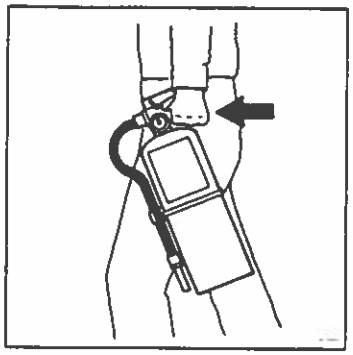
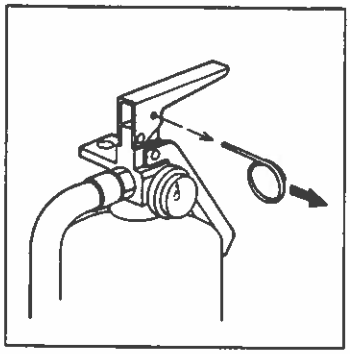


2

3. Pull the ring pin and remove the hose from its holder (if so equipped).
4. Proceed to the upwind side of the fire. Stay well clear of the flames. From this position, the air currents help carry the agent into the fire. It also assures maximum visibility and provides protection from the heat.



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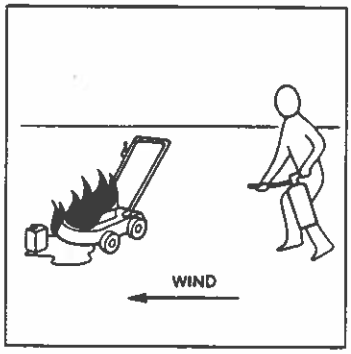

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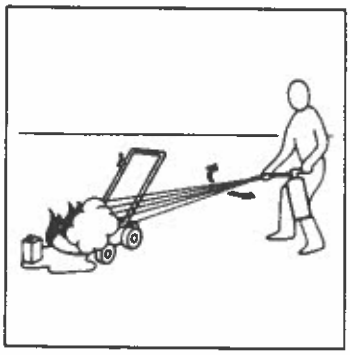
5. Position yourself at the distance recommended on the extinguisher nameplate, and squeeze the operating lever to the full open position. Direct the extinguishing agent at the base of the fire with a sweeping motion, covering the full width of the fire. Do not release the operating lever until the fire is completely extinguished.

NOTICE

For additional information on the proper use and extinguishment applications of Ansul fire extinguishers, Ansul has produced a comprehensive SENTRY Extinguisher Applications Video and offers hands-on fire fighting training at our fire school. Contact Ansul Fire Protection, One Stanton Street, Marinette, WI 54143-2542, or your Ansul Distributor.



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'A 10, 1988 Edition, 4-3.1: Extinguishers shall be inspected when initially placed in service and thereafter at approximately 30-day intervals. Extinguishers shall be inspected at more frequent intervals when circumstances require.

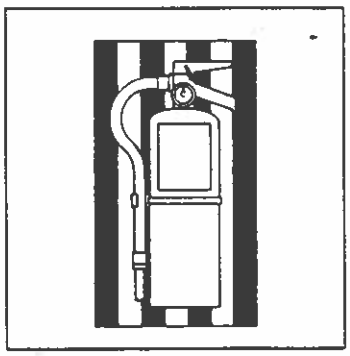
NOTICE

Become familiar with the Service and Repair section prior to performing Inspection.

To inspect the dry chemical and Halon 1211 extinguisher:

1. Make certain the extinguisher is in its designated place, is clearly visible and is accessible for immediate use. Any obstructions that obscure it, or that would otherwise impair its being readily accessible, should be removed.

2. Check service date to determine need for inspection or maintenance.



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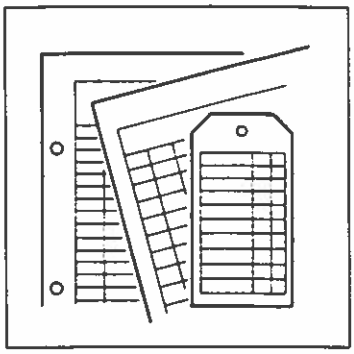

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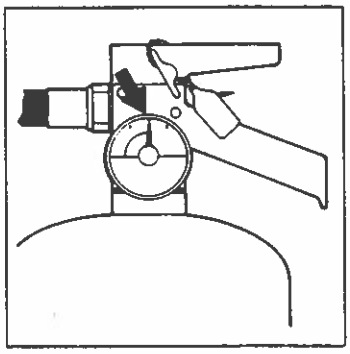
3. Check that pointer on extinguisher pressure gauge is in the operating range. (Upper and lower point of operating range normally reflects the operating temperature range of the extinguisher.)

NOTICE

The operating pressure of the Halon 1211 extinguisher varies with temperature. A Halon 1211 stored pressure extinguisher shall be recharged if a loss in pressure occurs, adjusted for temperature, exceeding 10% of the charging pressure. If a pressure loss is suspected, condition the extinguisher at 70 °F (21 °C) for 12 hours and then recheck the pressure reading. If gauge still shows a 10% pressure loss, the extinguisher must be recharged.



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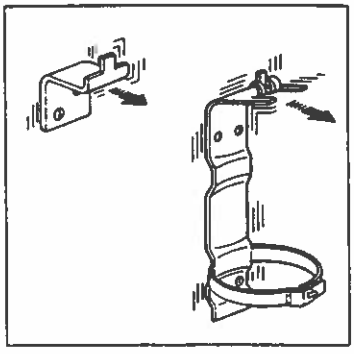

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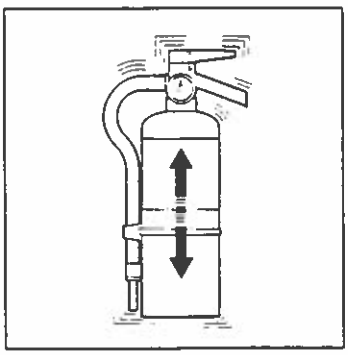
4. Remove the extinguisher from its wall hanger or bracket. Check that the hanger or bracket is secure enough to hold the extinguisher safely.

5. Heft (lift up and down slightly) the extinguisher to determine if it is charged with agent. When hefting a Halon extinguisher, also shake it side to side and listen for any rattles. Internal rattling indicates a loose or broken pick-up tube and the extinguisher must be removed from service, discharged, repaired and recharged before returning to service.

6. Examine the extinguisher shell and all external parts for evidence of physical damage, corrosion or other impairments.



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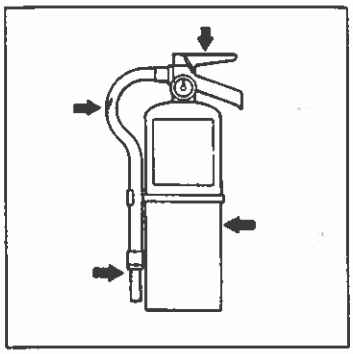

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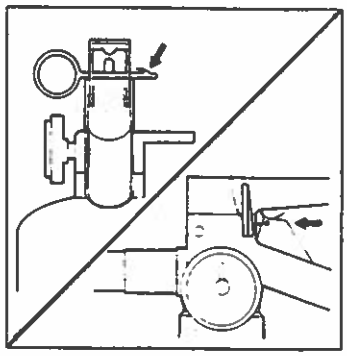
7. Check the visual inspection seal on metal ring pin models. Check that barb is intact on plastic pull pin models.

8. Check that the valve stem is in the full up position and that the stem has approximately 1/16 in. clearance.



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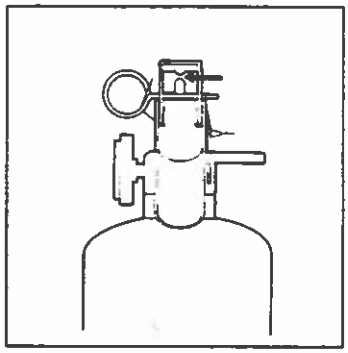
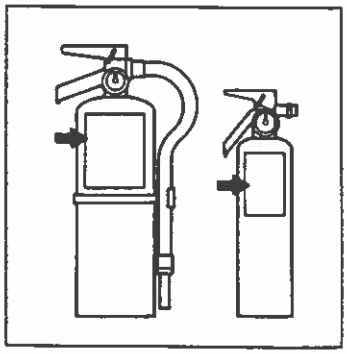


8

9. Check the nameplates for damage and readability.

10. Inspect the hose and/or nozzle for damage or obstructions. Insects are common causes of obstructions, particularly in warmer climates.



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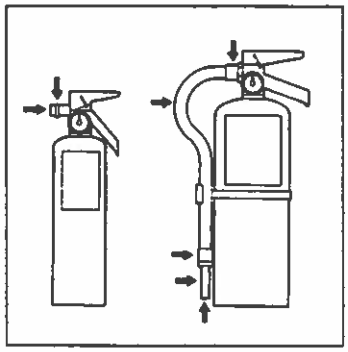

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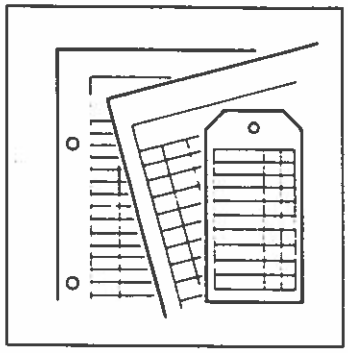
11. Record the date the inspection was performed and the initials of the person performing the inspection. Keep records of those extinguishers found to require corrective action.

12. Return the extinguisher to its designated place and secure.



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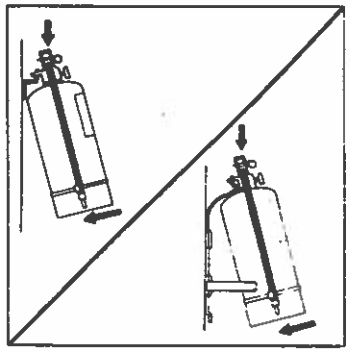


12

NFPA 10, 1988 Edition, 4-1.4: Maintenance, servicing and recharging shall be performed by trained persons having available the appropriate servicing manuals, the proper types of tools, recharge materials, lubricants and manufacturers recommended replacement parts.

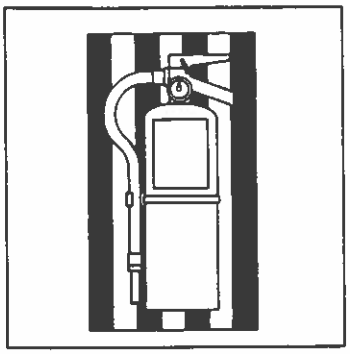
NOTICE

Always be alert for any indications of damage or inoperability in the unit. No manual can anticipate everything that could happen to a unit. In the event that something not covered in the manual is found, ascertain whether any potential for damage exists and repair or replace, as necessary. See Service and Repair Section, Page 24.

To maintain the dry chemical and Halon 1211 extinguishers:

1. Make certain the extinguisher is in its designated place, is clearly visible and is accessible for immediate use. Any obstructions that obscure it, or that would otherwise impair its being readily accessible, should be removed.

2. Check service date to determine need for inspection or maintenance.



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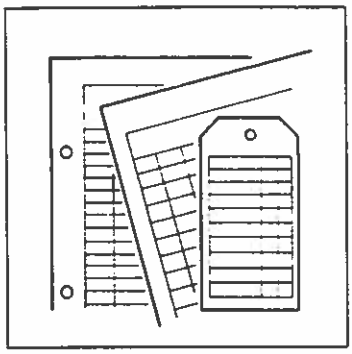

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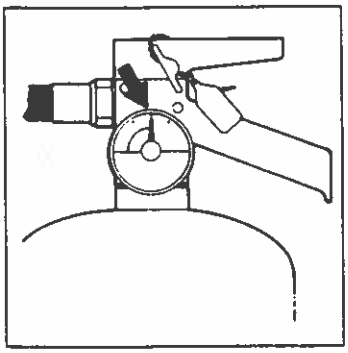
3. Check that pointer on extinguisher pressure gauge is in the operating range. (Upper and lower point of operating range normally reflects the operating temperature range of the extinguisher.) Ensure the gauge is the proper model for the extinguisher being maintained. Also check the gauge for mechanical damage. (For gauge replacement, see Service and Repair Section, Page 24.)

NOTICE

The operating pressure of the Halon 1211 extinguisher varies with temperature. A Halon 1211 stored pressure extinguisher shall be recharged if a loss in pressure occurs, adjusted for temperature, exceeding 10% of the charging pressure. If a pressure loss is suspected, condition the extinguisher at 70 °F (21 °C) for 12 hours and then recheck the pressure reading. If gauge still shows a 10% pressure loss, the extinguisher must be recharged.



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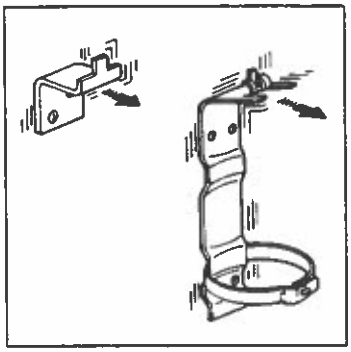

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4. Remove the extinguisher from its wall hanger or bracket. Check that the hanger or bracket is secure enough to hold the extinguisher safely.

NOTICE

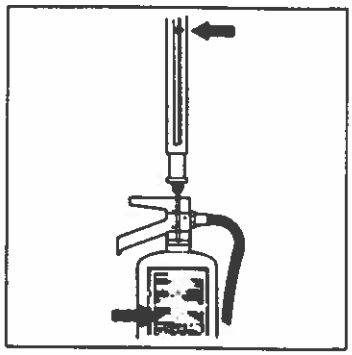
Extinguishers removed for maintenance or recharge shall be replaced by spare extinguishers of the same type and at least equal rating.

5. Weigh the extinguisher. Extinguisher weight MUST fall within the total charged weight limits as printed on the nameplate. Any extinguisher not meeting those limits MUST be properly recharged.

6. Check the date of manufacture stamped on the shell or the date of last hydrostatic test on the label affixed to the extinguisher to make certain it does not exceed the test interval of twelve years as specified in the current edition of NFPA Pamphlet 10 and Ansul Technical Bulletin Number 50.

NOTICE

Date stamp locations are: top collar, bottom skirt, or (after 1990) bottom dome of shell. These painted surfaces may require close examination to distinguish date.



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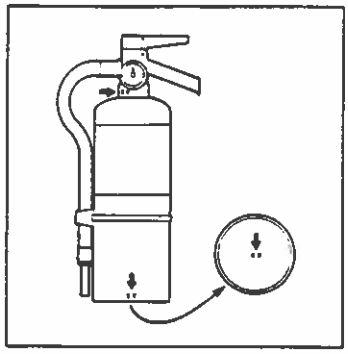


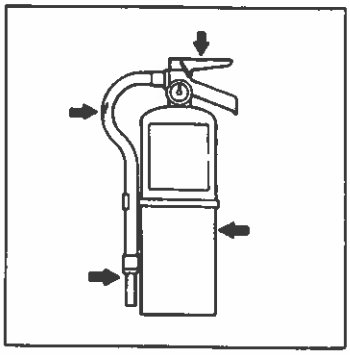
6

7. Examine the extinguisher shell and all external parts for evidence of burns, physical damage, corrosion or other impairments. Depending on the degree of corrosion or extent of mechanical damage, the extinguisher may constitute a potential hazard to persons in its vicinity, to operators or service personnel; and may require replacement or hydrostatic test.

NOTICE

Welding, soldering or brazing repairs to the extinguisher are not permissible.

8. Check the visual inspection seal on metal ring pin models. Check that barb is intact on plastic pull pin models.



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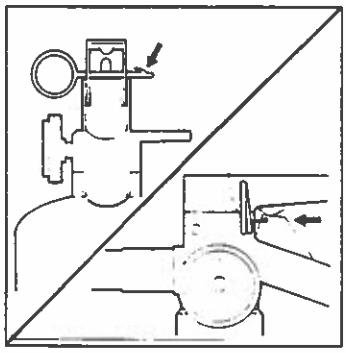

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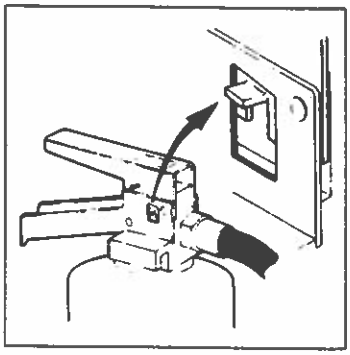
9. Older model extinguishers have a window (as shown) in the valve assembly. A metal tab should extend through that window. The tab restricts operating movement to protect the valve stem. If the tab is bent or missing, visually inspect the valve stem by lifting the operating lever. Refer to the Maintenance section for repair or replacement procedures.

10. Check that the valve stem is in the full up position and that the stem has approximately 1/16 in. clearance.

NOTICE

At the six year teardown, SENTRY Halon 1211 extinguishers require replacement of the valve stem assembly and valve body quad ring. Lightly lubricate new valve stem O-ring and valve body quad ring with Silicone Grease (Part No. 9030). Do not lubricate valve stem seat.



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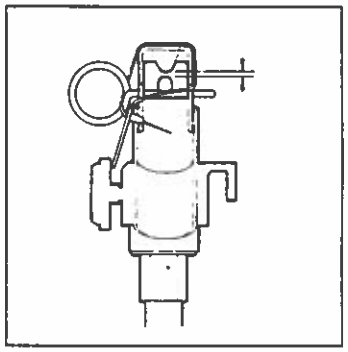

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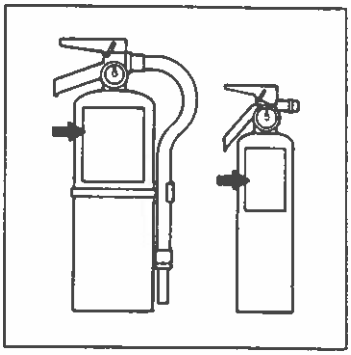
11. Check the nameplate for damage and readability. If operating instructions are not legible, an instructed (but not necessarily trained) person may not recall extinguisher operation in the excitement caused by a fire.

12. Remove hose and inspect hose and nozzle for obstructions, cuts, cracks or other mechanical damage. Insects are a common cause of obstruction, particularly in warmer climates.



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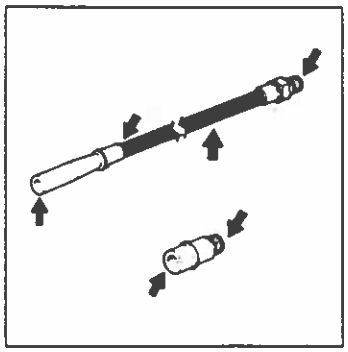
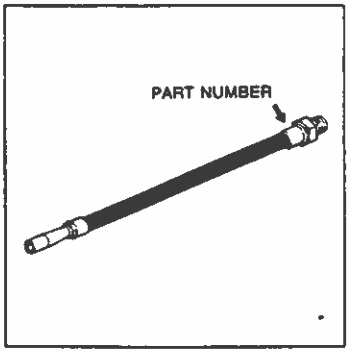


12

Ensure hose and nozzle are the proper assembly by matching the part number (stamped on hose coupling hex fitting or nozzle tip) with the extinguisher parts list.

14. On models equipped with an O-ring, remove O-ring, clean and lubricate with a light coat of Silicone Grease (Part No. 9030).



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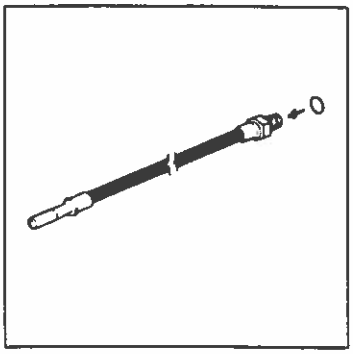

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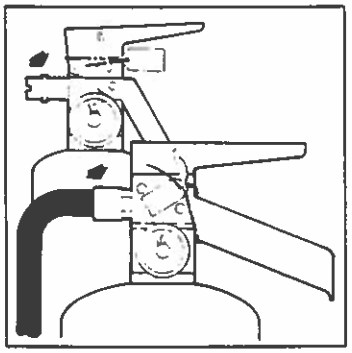
15. Reinstall O-ring to hose (if so equipped) and attach hose to valve assembly.

16. Clean all foreign deposits from the extinguisher and return to its designated location.



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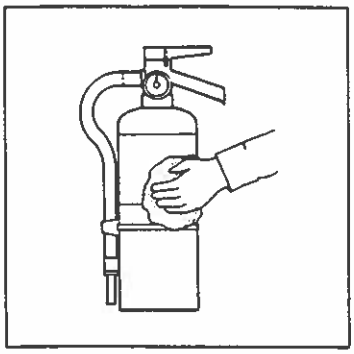
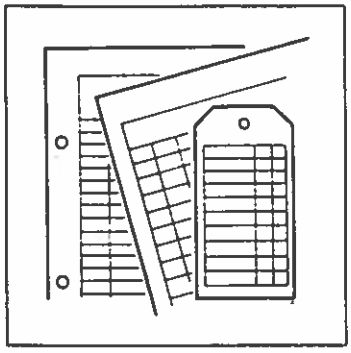


16

17. Each extinguisher shall have a tag or label securely attached that indicates the month and year the maintenance was performed and the identity of the person performing the service. The same tag or label shall indicate if recharging was also performed. The tag shall not be placed on the front of the extinguisher where it could obscure operating instructions.

    In addition to the required tag or label, a permanent file record should be kept for each extinguisher. This file record should include the maintenance date and the name of the person or agency performing the hydrostatic test; and a description of dents remaining after passing a hydrostatic test.



17

NOTICE

Before proceeding to recharge any extinguisher, visually examine the unit for any physical damage or impairment which may further dictate the need for maintenance.

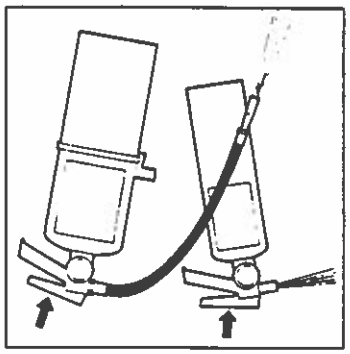
To return the dry chemical extinguisher to service after use:

1. Invert the extinguisher and, while holding nozzle assembly, press the lever to release all pressure.

2. Remove the hose and/or nozzle from the valve assembly and then remove the valve assembly from the shell by unscrewing it in a counterclockwise direction.

NOTICE

If recharging multiple extinguishers, keep the components for each extinguisher separate. Valve assemblies and shells are not indexed and labels will not line up properly if valve assemblies are transposed.



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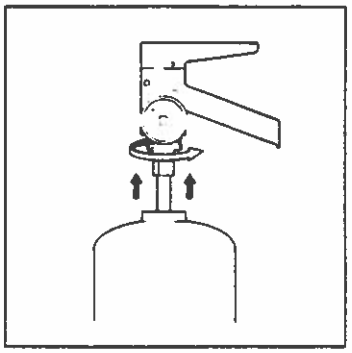


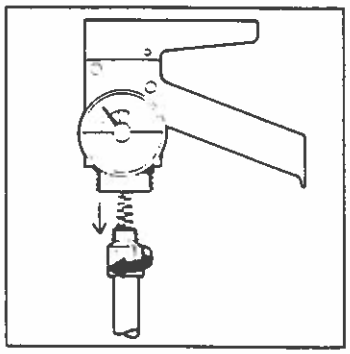
2

3. Remove the pick-up tube and spring from the valve assembly.

4. **⚠CAUTION**

Do not scratch internal valve surfaces. Scratching can result in valve leakage.

Remove the valve stem by pushing down on the operating lever and withdrawing stem. Clean the stem and the internal valve body with a soft cloth. Examine the stem seating surface and O-ring for cuts, scratches or other damage. Old style plastic valve stems are obsolete. Replace with the appropriate new style metal stems.



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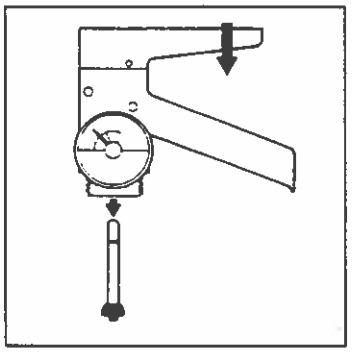

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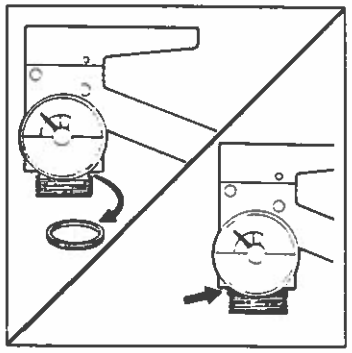
5. Remove quad ring. Clean dry chemical from the valve and quad ring groove. Inspect the quad ring for damage, replace if necessary. Lubricate the quad ring with a light coat of silicone grease (Part No. 9030) and return to valve assembly. Make certain quad ring is not twisted.

6. Older model extinguishers have a window (as shown) in the valve assembly. A metal tab should extend through that window. The tab restricts operating movement to protect the valve stem. If the tab is bent or missing, visually inspect the valve stem by lifting the operating lever. Refer to the Maintenance section for repair or replacement procedures.



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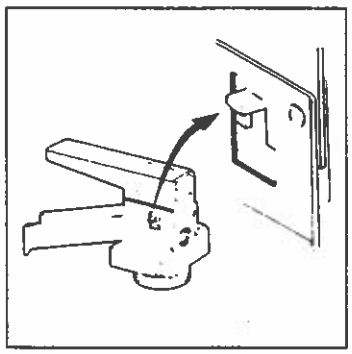

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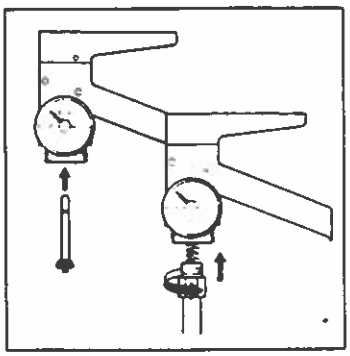
Inspect the pick-up tube and verify that the tube is not blocked and is secure. Use a light coat of silicone grease (Part No. 9030) to lubricate the metal valve stem O-ring, and reassemble the valve body with the cleaned metal valve stem assembly, spring, and pick-up tube. Wrench-tighten the pick-up tube to prevent expellent gas leakage.

8. On 2 1/2, 5 and 6 lb. models with aluminum handles, lift the operating lever and apply a coating of LUBRIPLATE grease or equivalent (not silicone) to the top of the valve stem.



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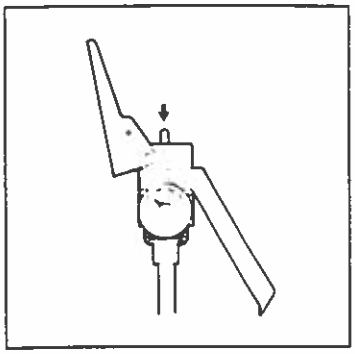

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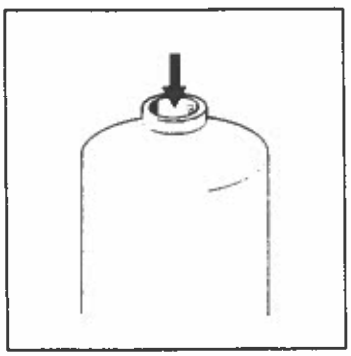
9. Visually inspect the interior of the tank for any corrosion or foreign materials. If the tank is corroded, it should be replaced. If foreign materials are present, thoroughly clean and dry the tank before refilling.

10. Place all extinguisher components on a scale and fill extinguisher using only the Ansul dry chemical specified on the nameplate. Fill to total charged weight listed on the nameplate. The weight of the dry chemical is critical. Overfilling may render the extinguisher ineffective.

    The remaining dry chemical in a discharged extinguisher may be reused provided that it is thoroughly checked for the proper type, contamination and condition. Dry chemical found to be of the wrong type, or contaminated shall not be reused.

NOTICE

To avoid scratching the quad ring seating surface, use a plastic rather than metal funnel when filling extinguisher.



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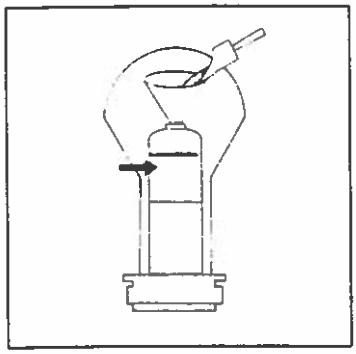

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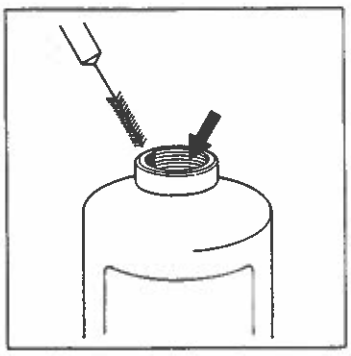
11. Clean the dry chemical from the quad ring seating surface and the threads of the shell with a stiff bristle brush.

12. **⚠CAUTION**

    Use care when inserting the valve assembly into the shell. Scratches on the quad ring seating surface can cause the extinguisher to leak.

    Screw the valve assembly into the shell until properly seated (hand tight).



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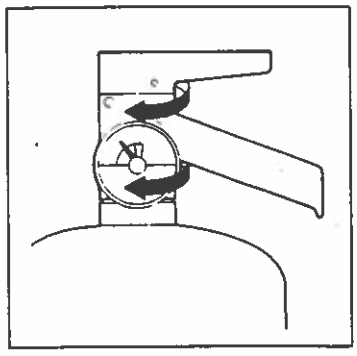

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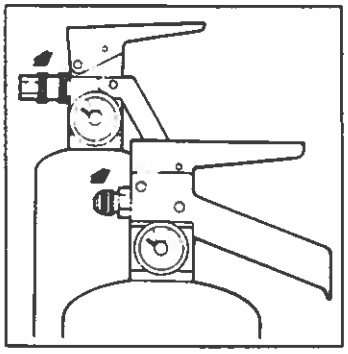
13.

⚠CAUTION

- The pressure gauge on the extinguisher should not be used to determine whether the intended charging pressure has been reached. Use the calibrated gauge on the Recharge System to determine if the correct pressure is being applied.
- Never leave a regulated high pressure source connected to an extinguisher for an extended period of time. A defective regulator could cause a violent failure of the extinguisher due to excess pressure buildup.
- Never set the regulator higher than 25 psi (172 kPa) over the extinguisher operating pressure.
- Never stand directly in front of extinguisher gauge when pressurizing.

Install recharge system (Part No. 55793) using recharge adaptor specified on the applicable parts list.



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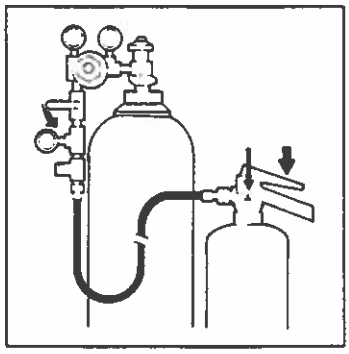

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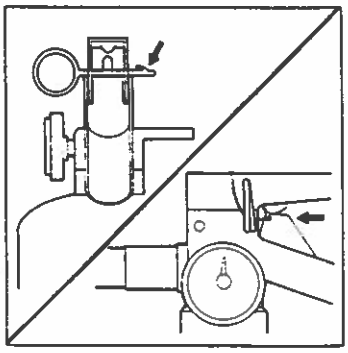
14. **Make certain nitrogen cylinder regulator is preset at 210 psi (1448 kPa) or lower before opening nitrogen cylinder valve.** Open nitrogen cylinder valve. Open recharge system ball valve, press lever and pressurize to proper extinguisher operating pressure with dry nitrogen. Release lever, close ball valve. Extinguisher gauge pointer should be in the GREEN operating range. If not, check gauge. Replace if necessary by referring to Page 18 of the Appendix.

15. On models with plastic pull pins, insert a new pull pin until the barb locks it in place. On models with metal ring pins, reinsert the ring pin and install a new visual inspection seal. Then, relieve pressure from recharge system at the regulator and remove the recharge adaptor.

16. Also, on metal ring pin models or when replacing plastic pull pins with metal, check that there is approximately 1/16 in. (1.6 mm) clearance between the top of the valve stem and the push lever.



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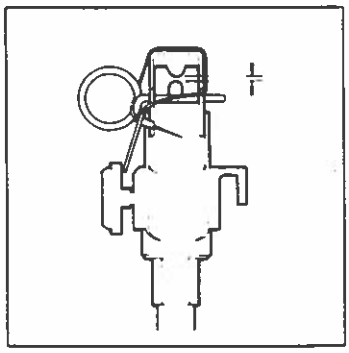

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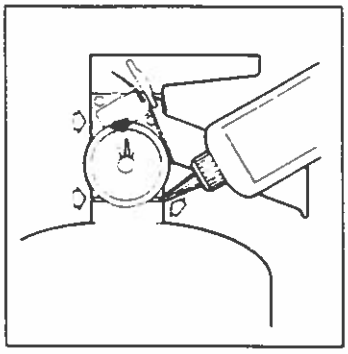
17. Test for leakage using LEAK-TEC FORMULA 177 or equivalent. Observe gauge 24 to 48 hours after recharge. There should be no loss of pressure. If gauge shows a pressure loss, raise the pressure and retest for leakage. If gauge again shows a pressure loss, depressurize and recharge.

NOTICE.

Ensure all valve areas are thoroughly dried before placing unit back in service.

18. Inspect hose and nozzle for obstructions, cuts, cracks or other mechanical damage. Insects are common causes of obstructions, particularly in warmer climates.



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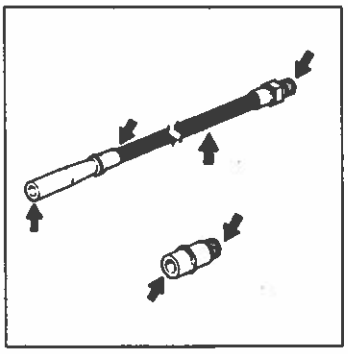


18

Check the hose couplings for tightness, corrosion or cracks. Reinstall hose and/or nozzle.

NOTICE

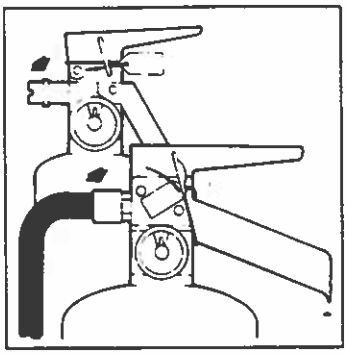
A loose connection of coupling to valve assembly or nozzle could contribute to a significant change in discharge characteristics upon use. A corroded or cracked coupling could separate under pressure.

20. Each extinguisher shall have a tag or label securely attached that indicates the month and year recharging was performed and the identity of the person performing the service. Record date of recharge on this tag or label and notify operating personnel that the extinguisher is back in service.

    In addition to the required tag or label, a permanent file record should be kept for each extinguisher. This file record should include the maintenance or recharge date and the name of the person or agency performing the hydrostatic test; and a description of dents remaining after passing a hydrostatic test.

NOTICE

NFPA 10, 1988 Edition, 4-4.1.3: Every six years, stored pressure extinguishers that require a 12-year hydrostatic test shall be emptied and subjected to the applicable maintenance procedures. When the applicable maintenance procedures are performed during periodic recharging or hydrostatic testing, the six-year requirement shall begin from that date.



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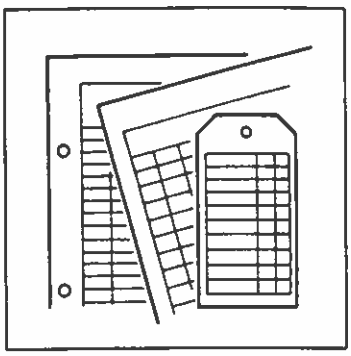


20

⚠WARNING

Always wear gloves and goggles or a face shield as Halon 1211 could cause freezing if sprayed on bare skin or in the eyes.

⚠CAUTION

Ensure the area in which reclaim is to be performed is properly ventilated.

Do not allow smoking in the area of Halon transfer, reclaim or recharge operations.

Properly identify cylinders containing contaminated Halon and keep them separate from pure rechargable Halon supplies.

To return Halon 1211 extinguisher to service after use:

1. With extinguisher in an upright position, release all pressure from extinguisher, reclaiming Halon 1211 according to procedures on Page 18 of the Appendix.

NOTICE

Halon 1211 has been classified under the Montreal Protocol as an ozone depleting chemical. Its release into the atmosphere for any reason other than fire extinguishment MUST be minimized. Following the Halon 1211 reclaim procedures will minimize Halon 1211 release.

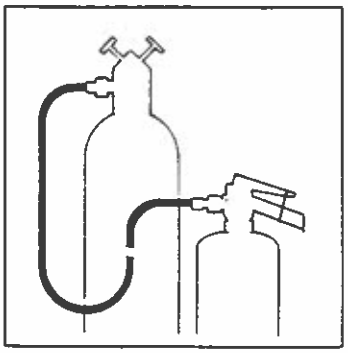
2. **⚠CAUTION**

Any pitting or corrosion of the shell indicates that excessive moisture has been introduced into the shell and **The entire unit is not rechargeable.** Mark shell "REJECTED" and return to owner without recharging. Shell is to be properly destroyed to prevent reuse.

NOTICE

If recharging multiple extinguishers, keep the components for each extinguisher separate. Valve assemblies and shells are not indexed and nameplates may not line up properly if valve assemblies are transposed.

Remove the hose and/or nozzle from the valve assembly and then remove the valve assembly from the shell. Check the shell for corrosion and/or Halon 1211 contamination.



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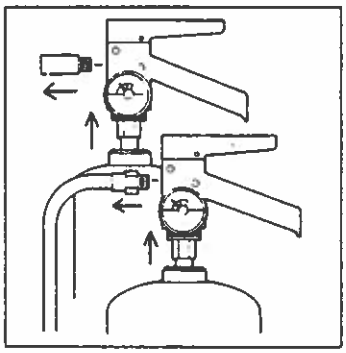
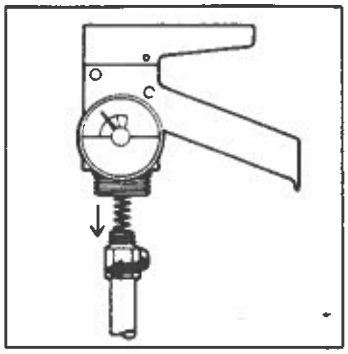


2

⚠CAUTION

Thoroughly examine internal components and shell for pitting or corrosion caused by contaminated Halon 1211. If pitting or corrosion is present, replace damaged parts (including gauge) or in severe cases, remove the unit from service.

Remove the pick-up tube and spring from the valve assembly. Inspect the valve spring and pick-up tube for any pitting or corrosion. Check the length of the pick-up tube by holding it next to the shell. The pick-up tube should be about 1/4 inch shorter than the shoulder to base length of the shell. If the pick-up tube is too short, replace with proper part (see extinguisher parts list).



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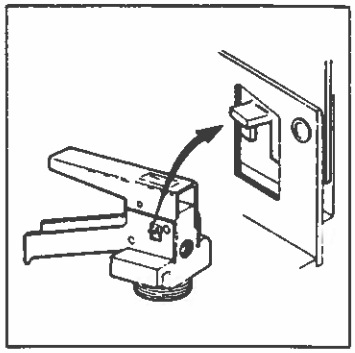

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4. Older model extinguishers have a window (as shown) in the valve assembly. A metal tab should extend through that window. The tab restricts operating movement to protect the valve stem. If the tab is bent or missing, visually inspect the valve stem by lifting the operating lever. Refer to the Maintenance section for repair or replacement procedures.

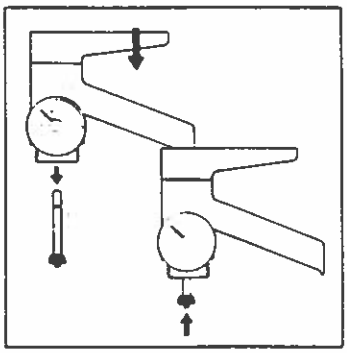
NOTICE

At the six year teardown, SENTRY Halon 1211 extinguishers require replacement of the valve stem assembly and valve body quad ring. Lightly lubricate new valve stem O-ring and valve body quad ring with Silicone Grease (Part No. 9030). Do not lubricate valve stem seat.

⚠CAUTION

Do not scratch internal valve surfaces. Scratching can result in valve leakage.

Remove the valve stem from the valve body, taking care not to scratch the valve seating area or damage the valve stem and O-rings. Remove O-rings from the valve stem and inspect for any damage; replace if necessary. Lubricate O-rings with Silicone Grease (Part No. 9030) and return O-rings to valve stem. Then return valve stem to valve body.



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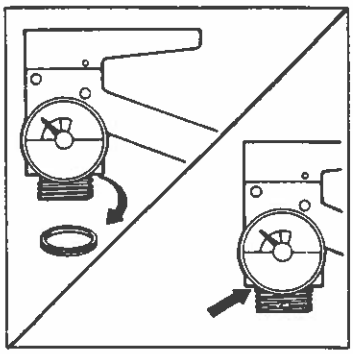
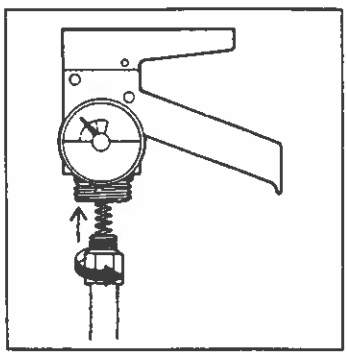


6

6. Remove quad ring from valve body. Inspect for any damage and replace if necessary. Lubricate the quad ring with Silicone Grease (Part No. 9030) and return to quad ring groove on valve body.

7. Inspect pick-up tube and verify that the tube is not blocked and is securely attached to the adaptor.Reinstall spring and pick-up tube into the valve body. Wrench tighten pick-up tube.



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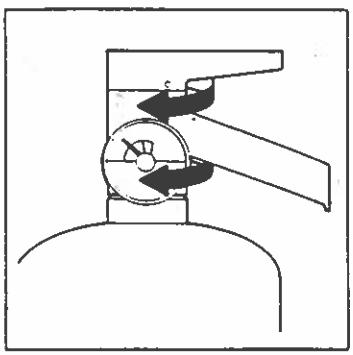

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8. **⚠CAUTION**

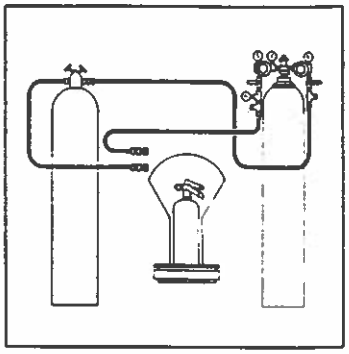
Use care when inserting the valve assembly into the shell. Scratches on the quad ring seating surface can cause the extinguisher to leak.

9. Make certain all equipment is connected and all valves are closed on Halon 1211 Recharge System (see Page 17 of the Appendix).

NOTICE

To avoid overpressurization of extinguisher, the Halon supply tank, the nitrogen supply and the extinguisher shell should be at 70 °F (21 °C) before recharging.

10. **Make certain the regulator (in the nitrogen supply to the Halon 1211 supply tank) is preset at 100 psi (689 kPa) or lower before opening the nitrogen cylinder valve.** Open nitrogen cylinder valve and adjust regulator so that calibrated gauge reads 100 psi (689 kPa). DO NOT EXCEED 125 PSI (862 kPa). Open Red Valve on halon supply tank to pressurize.



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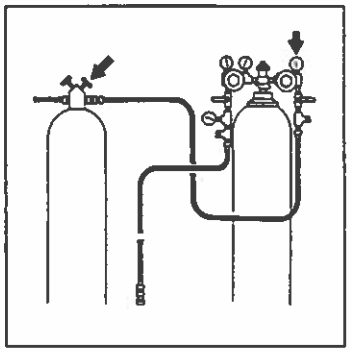

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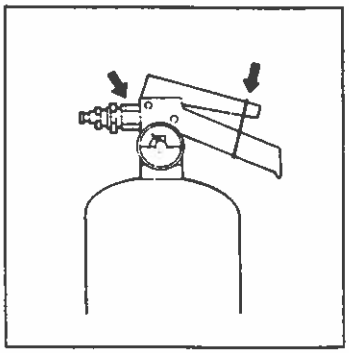
11. Install recharge adaptor Part No. 24034 for 2 1/2 lb. model or Part No. 32639 for all larger models. Also, place an O-ring over the push lever handle. Use 1 in. I.D. x 1/8 in. cross section O-ring (Part No. 6821) for 2 1/2 lb. model or 1 1/4 in. I.D. x 1/8 in. cross section O-ring (Part No. 32640) for all larger models.

12. **⚠CAUTION**

Only dry Halon 1211 may be used. Introduction of moisture into the extinguisher will result in corrosion and ultimate extinguisher malfunction.

Place cylinder on weigh scale and connect hose from Blue Valve on halon supply tank to fill adaptor on extinguisher. Set scale for the charged weight as shown on the extinguisher nameplate.



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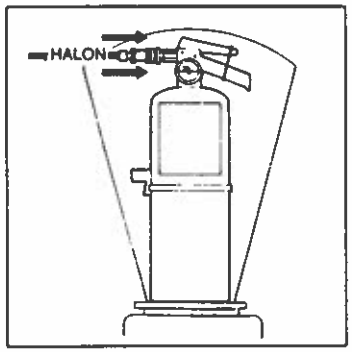

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13. Open Blue Valve on halon supply tank until extinguisher is filled with only Halon 1211 to the rated capacity. Then close Blue Valve and remove O-ring from push lever.

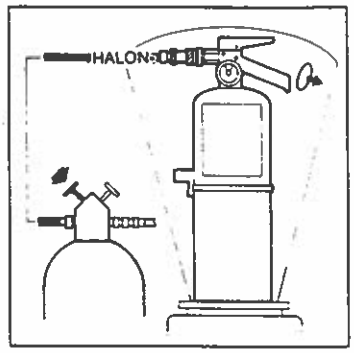
14. **⚠CAUTION**

Only dry nitrogen may be used. Introduction of moisture into the extinguisher will result in corrosion and ultimate extinguisher malfunction.

The nitrogen charging regulator should be set to no more than 25 psi above the extinguisher's normal charged pressure.

The pressure gauge on the extinguisher should not be used to determine whether the intended charging pressure has been reached. Use the calibrated gauge on the Recharge System to determine if the correct pressure is being applied.

Disconnect the halon supply hose from the extinguisher fill adaptor. Make certain the regulator (in the nitrogen pressurization line) is preset at or below the nominal operating pressure required for the extinguisher. Connect the nitrogen pressurization hose to the extinguisher fill adaptor.



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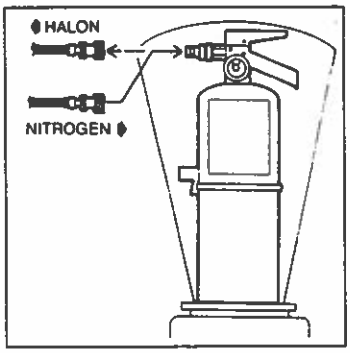

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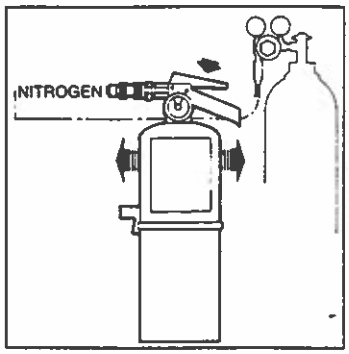
The calibrated gauge on the regulator should read the nominal operating pressure for that extinguisher (indicated in the GREEN operating range of the extinguisher pressure gauge). DO NOT OVERPRESSURIZE. Set the nitrogen cylinder regulator no higher than 25 psi (172 kPa) over normal extinguisher operating pressure. Depress the push lever to charge extinguisher to indicated pressure at 70 °F (21 °C). During pressurization, agitate or shake the extinguisher for 30 seconds to assure that proper superpressurization of extinguisher occurs. Then, release push lever.

16. Disconnect the hose from the nitrogen supply tank. Check that the extinguisher pressure gauge reads in the GREEN operating range. If not, replace the gauge by referring to Service and Repair Section, Page 25.



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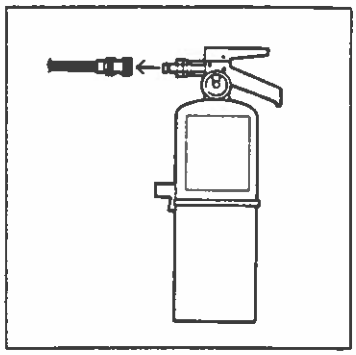
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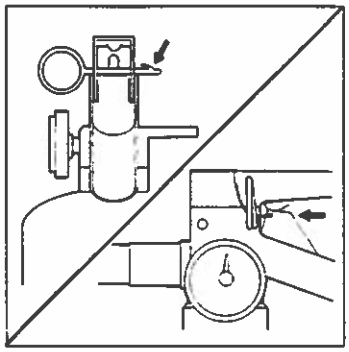
17. On models with plastic pull pins, insert a new pull pin until the barb locks it in place. On models with metal ring pins, reinsert the ring pin and install a new visual inspection seal. Then, remove the recharge adaptor.

18. Also, on metal ring pin models or when replacing plastic pull pins with metal, check that there is approximately 1/16 in. (1.6 mm) clearance between the top of the valve stem and the push lever.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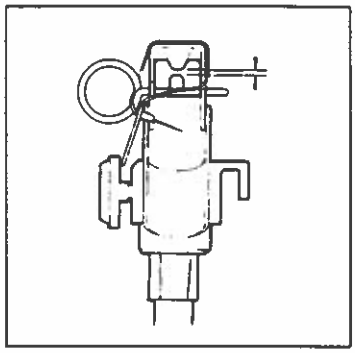
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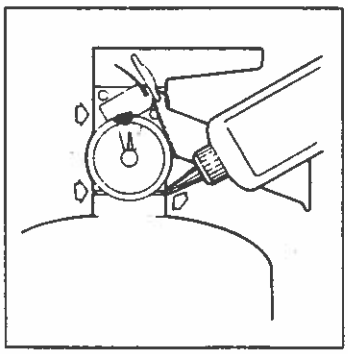
19. Test for leakage using LEAK-TEC FORMULA 177 or equivalent. Observe gauge 24 to 48 hours after recharge. There should be no loss of pressure. If gauge shows a pressure loss, raise the pressure and retest for leakage. If unit still leaks, depressurize and repeat recharge procedure.

NOTICE

Ensure all valve areas are thoroughly dried before placing the unit back in service.

20. Inspect the hose and/or nozzle for damage or obstructions. Insects are common causes of obstructions, particularly in warmer climates.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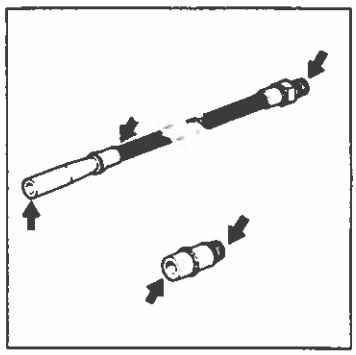

20

21. Check the hose couplings for tightness, corrosion or cracks. Reinstall hose and/or nozzle.

NOTICE

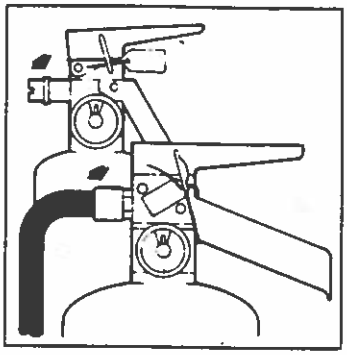
A loose connection of coupling to valve assembly or nozzle could contribute to a significant change in discharge characteristics upon use. A corroded or cracked coupling could separate under pressure.

22. Each extinguisher shall have a tag or label securely attached that indicates the month and year recharging was performed and the identity of the person performing the service. The tag shall not be placed on the front of the extinguisher where it could obscure operating instructions. Record date of recharge on this tag or label and notify operating personnel that the extinguisher is back in service.

In addition to the required tag or label, a permanent file record should be kept for each extinguisher. This file record should include the maintenance or recharge date and the name of the person or agency performing the hydrostatic test; and a description of dents remaining after passing a hydrostatic test.

NOTICE

NFPA 10, 1988 Edition, 4-4.1.3: Every six years, stored pressure extinguishers that require a 12-year hydrostatic test shall be emptied and subjected to the applicable maintenance procedures. When the applicable maintenance procedures are performed during periodic recharging or hydrostatic testing, the six-year requirement shall begin from that date.



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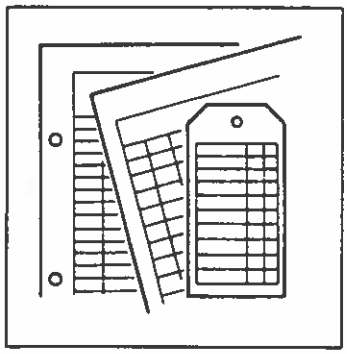
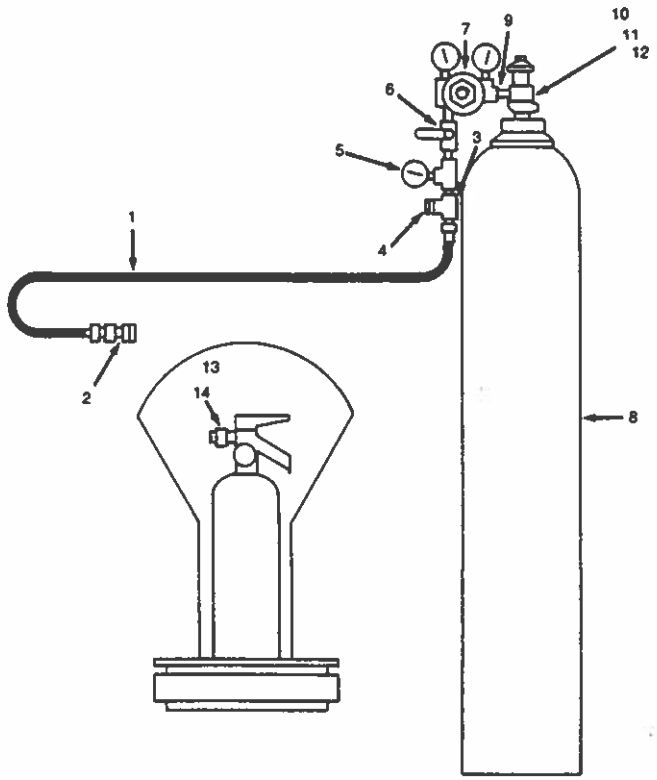


22

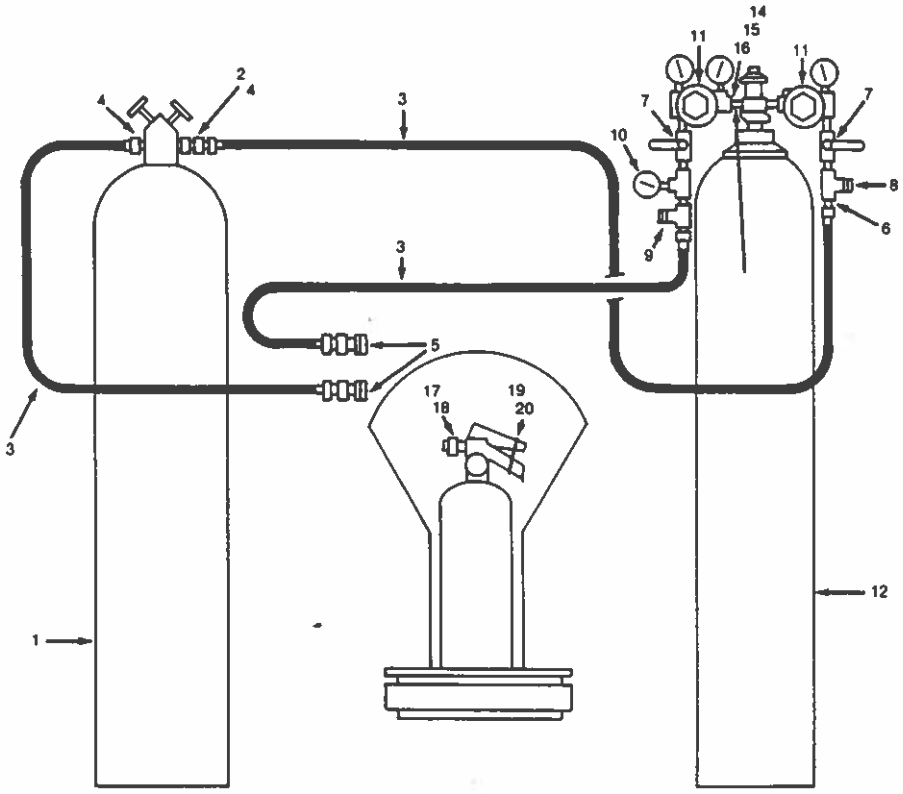
CHEMICAL RECHARGE SYSTEM

Item	Part No.	Qty.	Description
1	32633	1	Hose Assembly, 1/4 in.
2	32636	1	Coupler, Quick-Connect, Valved, 1/4 in.
3	27350	2	Tee, 1/4 in.
4	70452	1	Valve, Relief, 1/4 in. - 300 psi (2068 kPa)
5	29788	1	Gauge, Calibrated, 1000 psi (6894 kPa) with Restrictor
6	26000	1	Ball Valve, 1/4 in.
7	68819	1	Regulator, Adjustable, Inlet 0-3000 psi (0-20682 kPa), Outlet 0-1000 psi (0-6894 kPa), Self-Relieving with Gauges, 1/4 in. Inlet and Outlet Connections
8	11200	1	Cylinder, Nitrogen, Assembly, 400 cu. ft.
9	1778	1	Nipple, Schedule 80, 1/4 in.
10	12791	1	Tee, Schedule 80, 1/4 in.
11	3384	1	Nipple
12	3799	1	Nut
13	25743	1	Adaptor, Charging (For 2 1/2 lb. and SY-0515 Models)
14	16246	1	Adaptor, Charging (For 6, 10, and 20 lb.; and SY-0514 and Earlier 5 lb. Models)



HALON 1211 RECHARGE SYSTEM

Item	Part No.	Qty.	Description
1	32644	1	Cylinder, Halon 1211
2	32632	1	Union, Swivel Adaptor
3	32633	3	Hose Assembly, 1/4 in.
4	- - -	2	Bushing, Reducing, 3/4 in. x 1/4 in.
5	32636	2	Coupler, Quick-Connect, Valved, 1/4 in.
6	27350	3	Tee, 1/4 in.
7	26000	2	Ball Valve, 1/4 in.
8	34643	1	Valve, Relief, 1/4 in. - 125 psi (862 kPa)
9	70452	1	Valve, Relief, 1/4 in. - 300 psi (2068 kPa)
10	29788	1	Gauge, Calibrated, 1000 psi (6894 kPa) with Restrictor
11	68819	2	Regulator, Adjustable, Inlet 0-3000 psi (0-20682 kPa), Outlet 0-1000 psi (0-6894 kPa), Self-Relieving with Gauges, 1/4 in. Inlet and Outlet Connections
12	7847	1	Cylinder, Nitrogen, Assembly, 400 cu. ft.
13	1778	2	Nipple, Schedule 80, 1/4 in.
14	12791	1	Tee, Schedule 80, 1/4 in.
15	3384	1	Nipple
16	3799	1	Nut
17	24034	1	Adaptor, Charging (For 2 1/2 lb. Model)
18	32639	1	Adaptor, Charging (For Models Larger Than 2 1/2 lb.)
19	6821	1	O-Ring, No. 214 (For 2 1/2 lb. Model)
20	32640	1	O-Ring, No. 218 (For Models Larger Than 2 1/2 lb.)



ON 1211 RECLAIM PROCEDURES

⚠CAUTION

Ensure the area in which reclaim is to be performed is properly ventilated.

Do not allow smoking in the area of Halon transfer, reclaim or recharge operations.

Properly identify cylinders containing contaminated Halon and keep them separate from pure rechargable Halon supplies.

1. Check weight, gauge, or shake extinguisher to determine if there is any liquid agent remaining in the extinguisher.
2. Assemble Recharge System as indicated in the Figure and Ta ble below. Make certain Red and Blue Valves are closed.
3. Remove hose and/or nozzle from extinguisher and install recharge adaptor (Part No. 24034 for 2 1/2 lb. model or Part No. 32639 for larger models).
4. **⚠CAUTION**

   Any residual nitrogen pressure existing in the reclaim tank should be released through the Red Valve to a vented hood or outside atmosphere.

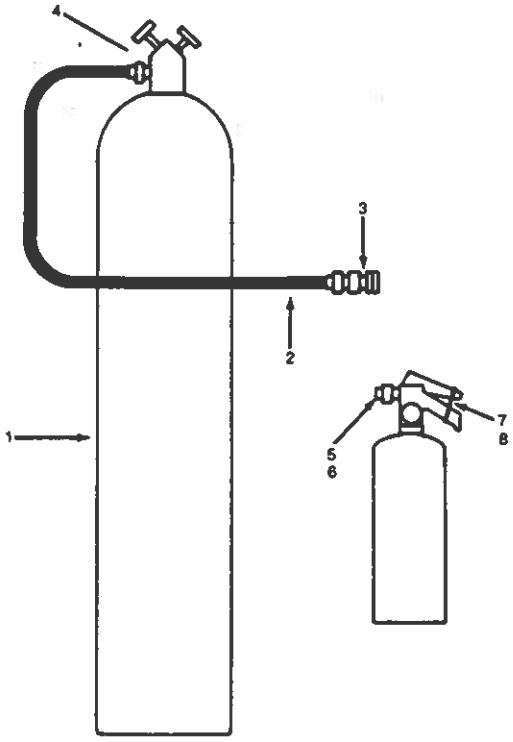
   Connect hose from Blue Valve on EMPTY reclaim tank to recharge adaptor on extinguisher using quick-connect coupler.
5. Open Blue Valve on reclaim tank. Install proper O-ring (see Figure and Table below) over extinguisher push lever and handle to allow Halon 1211 to flow from extinguisher to reclaim tank.
6. When extinguisher is empty, remove O-ring from push lever and close Blue Valve on reclaim tank. Then, disconnect hose from charging adaptor and remove charging adaptor from extinguisher valve.

NOTICE

Halon 1211 has been classified under the Montreal Protocol as an ozone depleting chemical. Its release into the atmosphere for any reason other than fire extinguishment MUST be minimized. Following these procedures will minimize Halon 1211 release.

HALON 1211 RECLAIM SYSTEM

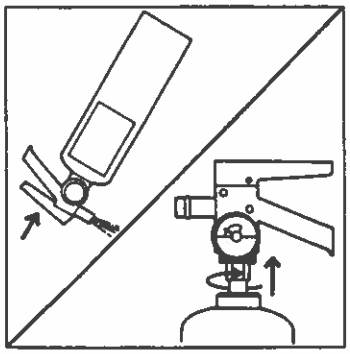
Item	Part No.	Description
1	32644 (empty)	Cylinder, Halon 1211
2	32633	Hose Assembly, 1/4 in.
3	32636	Coupler, Quick-Connect, Valved, 1/4 in.
4	32641	Bushing, Reducing, 3/4 in. x 1/4"
5	24034	Adaptor, Charging (For 2 1/2 lb. Model)
6	32639	Adaptor, Charging (For Models Larger Than 2 1/2 lb.)
7	6821	O-Ring, No. 214, (For 2 1/2 lb. Model)
8	32640	O-Ring, No. 218, (For Models Larger Than 2 1/2 lb.)



GAUGE REPLACEMENT PROCEDURES

1. Invert the extinguisher and press the lever to release all pressure. (For Halon 1211 models, Reclaim Halon 1211 according to procedures on Page 18 of Appendix.) Remove valve assembly.

2. Disassemble the valve assembly, removing the pick-up tube, valve stem, and spring.



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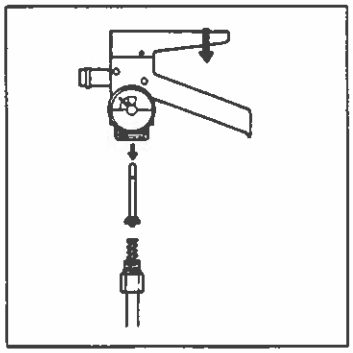
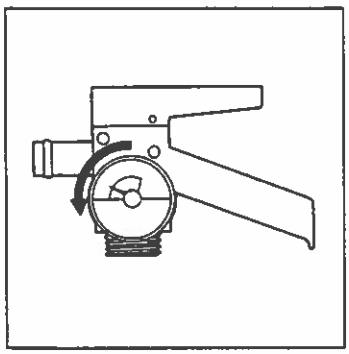


2

3. Remove damaged/defective gauge. If gauge is difficult to remove, immerse in hot water to loosen sealant.

4. Clean the gauge port threads. Use 1/8 – 27 NPT pipe tap to chase threads, if necessary. Be careful not to tap too deep as gauge will not tighten properly and valve assembly will have to be replaced. Be sure to select proper replacement gauge for the model extinguisher being repaired.



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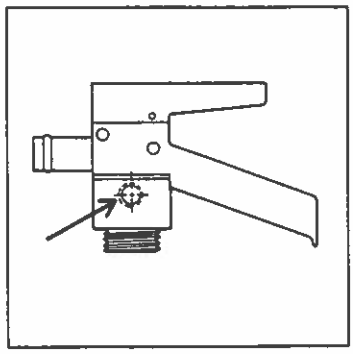
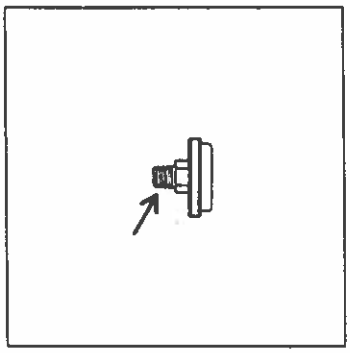


4

5. Apply plastic lead pipe sealant (ARMSTRONG C-4 w/Activator W or equivalent) to the threads of the new gauge. Be careful not to get any sealant into the hole in the face of the gauge socket. Ansul does not recommend the use of pipe tape.

6. Screw the new gauge into the valve body making certain that the operating range on the gauge face is pointed to the top of the valve.



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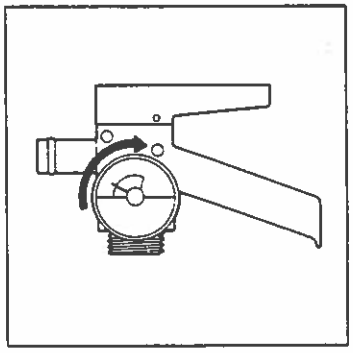
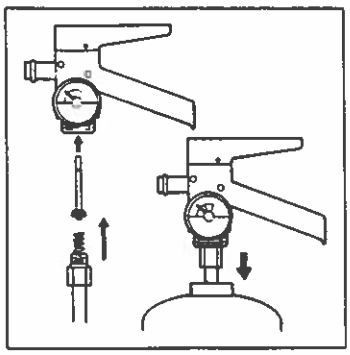


6

7. Clean valve body, lubricate, and reassemble. Recharge extinguisher and check for leakage (use LEAK-TEC FORMULA 177 or equivalent). If there is leakage through gauge threads, relieve pressure from extinguisher and tighten gauge one more turn. If leakage cannot be stopped, discard valve assembly.



7

\CKETS

....roduction

Brackets are available for each Ansul SENTRY hand portable extinguisher. Certain applications require extinguishers to be mounted in brackets for safety and restraint.

Installation and Mounting

Make certain mounting location and position meet NFPA-10 requirements.

Brackets may be mounted in a vertical, horizontal or sloping position on sufficiently strong, stationary supporting surfaces or within suitable vehicle compartments.

The brackets are provided with mounting holes in the back plate (frame) and /or mounting holes in the base. The mounting surface will usually dictate that either the back or the base of the bracket be used but in some cases, both may be used to improve the weight distribution. Use good quality fasteners, one in each mounting hole. Fasteners should be tightened as recommended for the specific type and grade of fastener used.

Even though welding is an effective method of securing the bracket in place, it is NOT recommended because Ansul has no control over the placement and quality of the welds.

Mounting Location

Two considerations will affect the choice of bracket mounting location.

The first is fire protection needs.

1. The extinguisher must be visible, not hidden in an out-of-the-way spot.
2. The extinguisher must be easy to reach.

   The extinguisher should not be placed where a fire is likely to make it inaccessible.

The second set of considerations deal with keeping the extinguisher safe and secure.

1. Avoid locations where grease or oil could build up on the extinguisher and bracket.
2. Select a relatively flat mounting surface which is strong enough to support the weight of the extinguisher and bracket.
3. Avoid surfaces which may flex enough to cause metal fatigue in the bracket support.
4. Be sure there is enough space to allow proper mounting of the bracket and easy access to the extinguisher.
5. Avoid locations that may expose the extinguisher to temperatures detrimental to its operation (such as too near a motor or exhaust manifold).

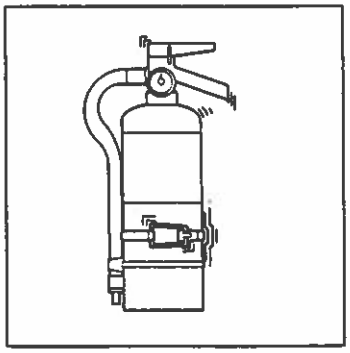
BRACKETS (Continued)

Inspection

Inspection of the bracket should be performed whenever extinguisher inspection is performed.

1. Check for looseness between the extinguisher and the bracket. The band clamp should shut tightly, compressing the band grommet.

2. Inspect the extinguisher and bracket for wear caused by movement of the extinguisher within the bracket.



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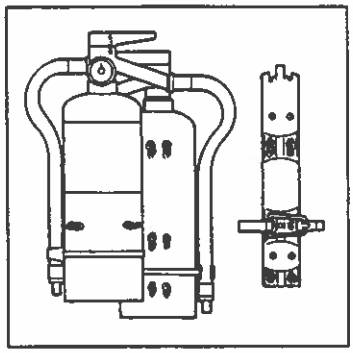
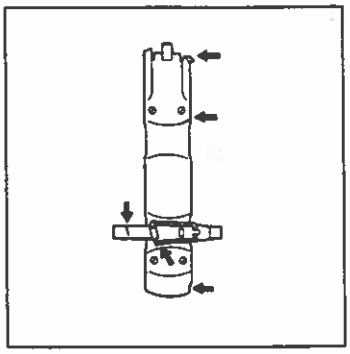


2

3. Examine the entire bracket closely for loose or worn hinges or hingepins, bent or cracked bands and worn or missing grommets. Avoid future damage by replacing or repairing all components that are missing, worn or damaged.



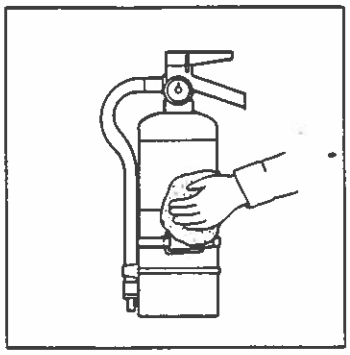
3

.CKETS (Continued)

Maintenance

Maintenance is a very important factor in the lifespan and reliability of a bracket. Bracket maintenance should be performed whenever extinguisher maintenance is performed.

1. Clean any dirt or other foreign material from the extinguisher and bracket using a brush, cleaning cloth or soap and water.
2. Remove the extinguisher from the bracket.and clean extinguisher surfaces which were in contact with the bracket.



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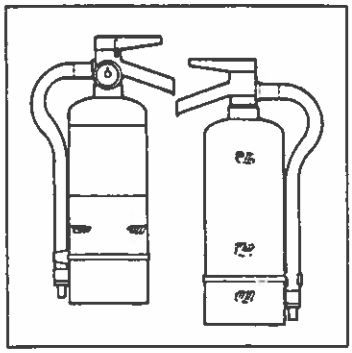
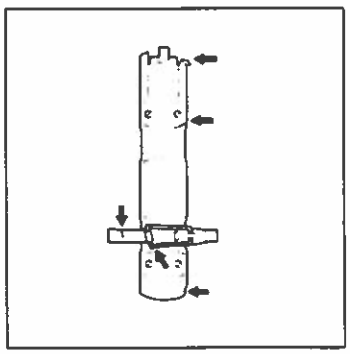


2

3. Inspect the bracket. If it is bent or cracked, replace it.
4. Check to see that the bracket is firmly mounted. Tighten or replace mounting fasteners.



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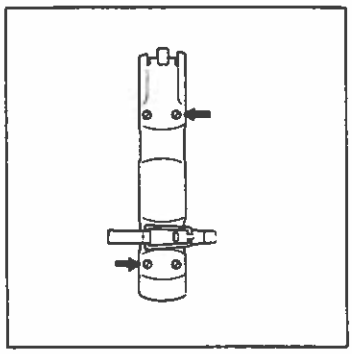
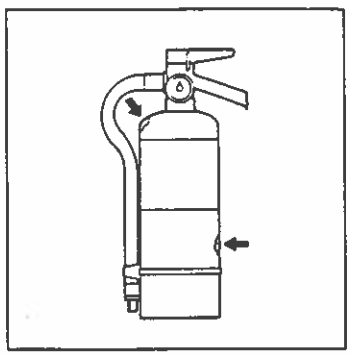


4

5. Avoid possible rust damage by cleaning and painting whenever bare metal is exposed.
6. Following extinguisher maintenance, secure the extinguisher in the bracket. If the bracket does not hold the extinguisher securely or the bracket is difficult to close, replace the affected part and/or the entire bracket.



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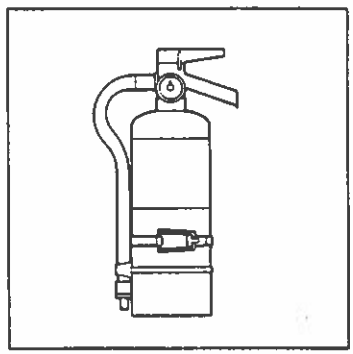


6

BRACKETS (Continued)

Models

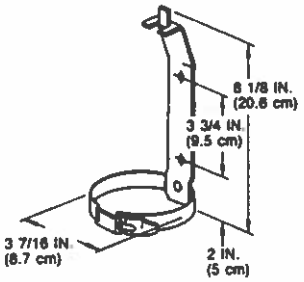
1. Part No. 24610

SY-0216
SY-0236
SY-0241
SY-0243

2. Part No. 68309

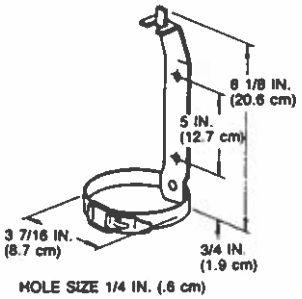
SY-0215
SY-0242

Part No. 24610



HOLE SIZE 1/8 IN. (.3 cm)

Part No. 68309



HOLE SIZE 1/4 IN. (.6 cm)

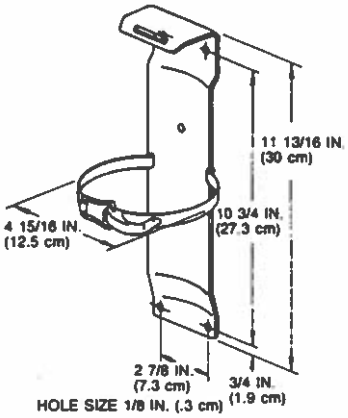
3. Part No. 31025

SY-0513
SY-0514
SY-0613
SY-0614
SY-0621
SY-0622
SY-0623
SY-0624
SY-0631
SY-0634

4. Part No. 54160

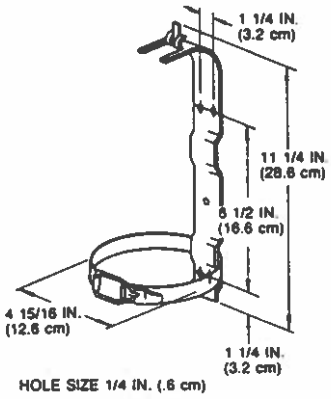
SY-0515

Part No. 31025



HOLE SIZE 1/8 IN. (.3 cm)

Part No. 54160



HOLE SIZE 1/4 IN. (.6 cm)

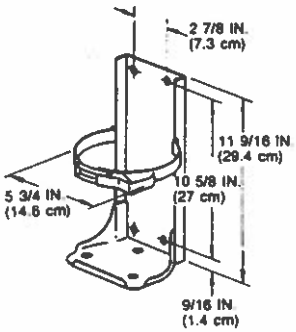
5. Part No. 32820

SY-0635
SY-0541
SY-0941

6. Part No. 30865

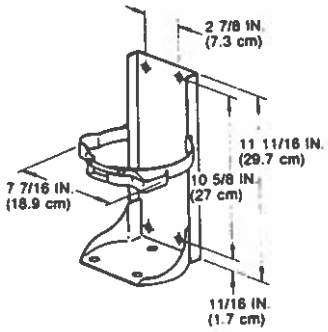
SY-1013
SY-1014
SY-1023
SY-1024
SY-1033
SY-1034
SY-1441

Part No. 32820



HOLE SIZE 3/8 IN. (1 cm)

Part No. 30865

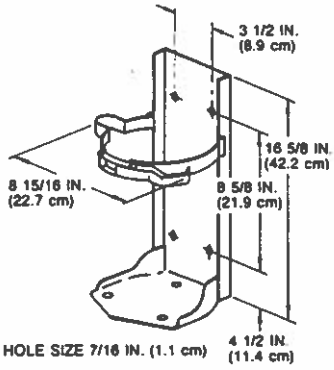


HOLE SIZE 3/8 IN. (1 cm)

7. Part No. 30937

SY-2013
SY-2014
SY-2023
SY-2024
SY-2033
SY-2034
SY-1741

Part No. 30937



HOLE SIZE 7/16 IN. (1.1 cm)

.VICING MATERIALS

The following are some additional materials and equipment available from Ansul to properly service stored pressure extinguishers in the field.

Special Tools

• Recharge system (dry chemical)	Part No. 55793
• Recharge system (Halon 1211)	Part No. 32631

Lubricants

• Silicone Grease for O-rings and Quad Rings	Part No. 9030

Touch-Up Paint

• Red – Pint Can (Requires no primer)	Part No. 77601

Labels and Tags

• Hydrostatic Test Label (Order from Ansul Marketing Services)	Part No. 11790
• Metal Inspection Tags	Part No. 4111
• Paper Inspection Tags	Part No. 2364
• Fire Extinguisher Maintenance and Recharge Record Form (Order from Ansul Marketing Services)	Form No. F-7288
• Six-year maintenance tags (Order from Ansul Marketing Services)	Part No. 79072

SERVICE AND REPAIR

COMPONENT	DISORDER	CORRECTIVE ACTION
Tank	Dents or abrasions	Hydrotest (See Form No. F-7602, Hydrostatic Test Instructions) or discard tank.
	Rust spots, pits or corrosion	Replace tank if there is any corrosion penetration.
	Threads nicked, cross-threaded, corroded or worn	If damaged or worn extensively the tank must be discarded.
	Leak in weld seam	Discard tank.
	Burn marks	Discard tank.
Extinguishing Agent	Improper fill level	Fill shell to rated capacity with Ansul extinguishing agent specified on nameplate.
	*Caked dry chemical	Discard agent and refill clean tank to rated capacity with Ansul extinguishing agent specified on nameplate.
Pickup Tube	Bent, cracked, broken or obstructed	Replace, using factory-built assembly only.
Valve	Leak through valve	Install new valve stem assembly or valve stem seal. Check valve seat for scratches or foreign matter.
	Leak around gauge threads	Depressurize extinguisher, remove gauge and reinstall with plastic lead pipe sealant (Armstrong C-4 w/Activator W or equivalent) on gauge threads.
	Defective or damaged gauge	Depressurize extinguisher, remove gauge and replace with proper gauge for extinguisher model being repaired. Use plastic lead pipe sealant (Armstrong C-4 w/Activator W or equivalent) on gauge threads.
	Low pressure on gauge	Check for leaks. Weigh extinguisher. Repressurize. Retest.
Nameplate	Unreadable	Use a mild detergent to clean plate. If readability cannot be improved, replace operating nameplate.**
	Loose	Inspect area under plate. If corroded, see "Tank – Rust spots, pits, corrosion" and reaffix nameplate using a good grade of heatless adhesive.
	Missing	Replace with correct nameplate.**
Hose	Cut, cracked or abraded	Replace hose assembly.
	Corroded or cracked coupling	Replace hose assembly.
	Internal blockage	Replace or clear by flexing or blowing air or nitrogen through the hose at 50 psi (345 kPa) or less.
	O-ring cut, brittle or missing	Replace, lubricating new O-ring lightly with silicone grease.
Nozzle	Wrong nozzle	Replace with proper model nozzle recommended by Ansul. Refer to Parts List.
	Nozzle body corroded, cracked or dented	Replace nozzle.
	Threads nicked, worn or cross-threaded	Replace nozzle.

*The term caked, as applied to dry chemical describes a specific condition that is best identified as dry chemical containing hard lumps. These lumps will render a dry chemical extinguisher inoperative. The condition usually follows the absorption and later the evaporation of an unusual amount of moisture. It is often confused with "packing" (a condition produced by normal settling, by vibration or impact). A simple procedure to determine which condition exists is the UL test in which lumps are dropped from 4 in. (10 cm) onto a clean, hard surface. If the lumps do not break up into individual particles, caking is present. For additional details, refer to Ansul Technical Bulletin No. 45 "Caking Versus Packing of Dry Chemical Agents" (Form No. F-8083).

**Replacement maintenance nameplates from Ansul will not have a UL manifest.

RANTY, DISCLAIMER AND LIMITATION

Your Ansul dry chemical or Halon 1211 stored pressure fire extinguisher, with the exception of the hose assembly (where applicable), is warranted to you as the original end-user purchaser for five years from the date of delivery against defects in workmanship and material. The hose assembly (where applicable) is warranted for one year from date of purchase by the original end-user purchaser. ANSUL DOES NOT ASSUME OR AUTHORIZE ANY OTHER PERSON TO ASSUME FOR IT, ANY OTHER LIABILITY IN CONNECTION WITH THE SALE OF ITS PRODUCTS. As its sole obligation, Ansul will replace or repair any Ansul supplied part which, in its opinion, is defective and has not been modified, tampered with or subjected to misuse or abuse or exposed to highly corrosive conditions and which has been properly maintained in accordance with the extinguisher maintenance manual if the part is returned postage paid to Marinette, WI with prior authorization through Ansul Quality Services Department.

EXCEPT AS PROVIDED ABOVE, THERE ARE NO OTHER WARRANTIES WHETHER EXPRESS OR IMPLIED MADE BY ANSUL CONCERNING THIS EXTINGUISHER. UNDER NO CIRCUMSTANCES SHALL ANSUL HAVE LIABILITY FOR ANY INCIDENTAL, CONSEQUENTIAL, SPECIAL OR SIMILAR DAMAGES.

For repairs, parts and service of the Ansul extinguisher, contact your local Ansul representative or Ansul Fire Protection, Wormald U.S., Inc., One Stanton Street, Marinette, Wisconsin 54143-2542; 715-735-7411.

APPENDIX C

Data Collection Quality Assurance Plan

HALEY ALDRICH

www.haleyaldrich.com

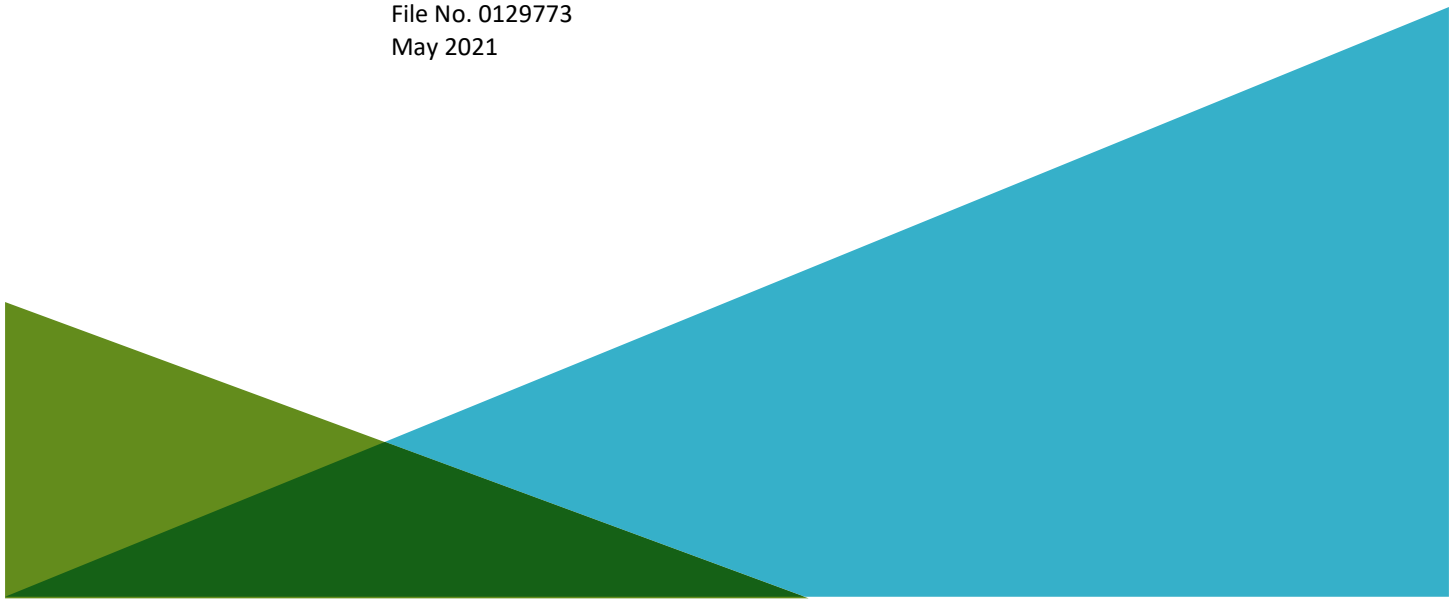
DATA COLLECTION QUALITY ASSURANCE PLAN

EDWARD ALLEN LANDFILL
CORNING, NEW YORK

by
Haley & Aldrich of New York
Rochester, New York

for
Edward Allen Landfill PRP Group
Corning, New York

File No. 0129773
May 2021



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List of Abbreviations

Abbreviation	Definition
%D	Percent Difference
%R	Percent Recovery
%RSD	Percent Relative Standard Deviation
CV	Coefficient of Variation
DCQAP	Data Collection Quality Assurance Plan
DQO	Data Quality Objective
ELAP	Environmental Laboratory Accreditation Program
GC	Gas Chromatography
ICP	Inductively Coupled Plasma Spectrometry
MS	Matrix Spike
MSD	Matrix Spike Duplicate
n	Number of Values
NTU	Nephelometric Turbidity Units
NYCRR	New York Code of Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
OVA	Organic Vapor Analyzer
PID	Photoionization Detector
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control
R	Average Range
RAP	Remedial Action Plan
Ri	Range
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RPD	Relative Percent Difference
S	Standard Deviation
Site	Edward Allen Landfill
SOP	Standard Operating Procedure
TAGM	Technical and Administrative Guidance Memorandum
USEPA	United States Environmental Protection Agency
X	Average or Arithmetic Mean
Xi	Set of n values

1. Introduction

1.1 PROJECT DESCRIPTION

The Edward Allen Landfill (Site) is an inactive municipal landfill located in the Town of Corning, New York. The landfill, owned by Mr. Edward Allen, reportedly received municipal and industrial waste between 1953 and 1979 and covers approximately 27 acres. The New York State Department of Environmental Conservation (NYSDEC) conducted Phase I and Phase II investigations at the Site in 1983 and 1985, respectively. In August 1987, the Allen Landfill PRP Group entered into an Order on Consent (#BS-0015-84-01) with NYSDEC for performance of a Remedial Investigation/Feasibility Study (RI/FS). The RI Report was completed in November 1990 and approved by NYSDEC in June 1991. The FS was submitted to NYSDEC in October 1991.

In March 1992, NYSDEC issued a Record of Decision (ROD) presenting a selected Remedial Action Plan (RAP) for the Site. In February 1993, the Allen Landfill PRP Group, and Mr. Edward Allen entered into an Order on Consent (#B8-0015-91-07) with NYSDEC to implement the RAP presented in the ROD. Following submittal and NYSDEC review of the Preliminary Remedial Design Report in April 1993, it was agreed between the Allen Landfill PRP Group and the NYSDEC that the design had progressed to a point which allowed for the completion of the Final
Remedial Design.

The Final Remedial Design Report (revised April 1994), Contract Drawings, Contract Documents (Specifications) and the Subsurface Investigation booklet represent the Final Remedial Design. The site remediation project, designed by O'Brien & Gere Engineers, Inc., and constructed in 1994 and 1995 by O'Brien & Gere Technical Services, Inc., includes the following major components:

- A synthetic cover system installed in accordance with technical requirements of 6 New York Code of Rules and Regulations (NYCRR) Part 360.
- A circumferential seepage collection trench to collect generated seepage. The collected seepage is stored in on-site underground storage tanks and periodically removed for off-site treatment.
- A surface water drainage ditch installed to direct ground water from moving through the landfill.
- A monitoring system (piezometers) installed within the limits of the landfill to monitor ground water elevation.
- A chain link fence installed around the Site to limit access

1.2 PURPOSE AND SCOPE

This Data Collection Quality Assurance Plan (DCQAP) is site-specific and has been prepared to support operation and maintenance of the Edward Allen Landfill Site. Specifically, this DCQAP addresses the ground water monitoring, surface water monitoring, air monitoring and homeowner well monitoring program activities to be conducted at the Site as described in the Operation and Maintenance Manual.

The objectives of this DCQAP are to provide sufficiently thorough and concise descriptions of the measures to be applied during operation and maintenance so that data generated will be of a known and acceptable level of precision and accuracy. This DCQAP provides comprehensive information regarding the project description and sets forth specific procedures to be used when obtaining environmental samples, performing other field activities, and performing laboratory analyses of samples.

2. Data collection strategy

The data generation process was designed to develop an analytical database of sufficient quality to be used to monitor performance of components of the Edward Allen Landfill remedial construction. Therefore, specific data quality requirements such as reporting limits, criteria for accuracy and precision, sample representativeness, data comparability, data completeness, data precision, and data accuracy are specified in this document.

2.1 DATA QUALITY OBJECTIVES

Data quality objectives (DQOs) are quantitative and qualitative statements specifying the quality of the environmental data required to support the decision-making process. DQOs define the total uncertainty of the data acceptable for each specific activity during the investigation. The uncertainty includes both sampling error and analytical error. Ideally, zero uncertainty is the intent. However, the variables associated with the process (field and laboratory) inherently contribute to the uncertainty of the data. It is the overall objective to keep the total uncertainty within an acceptable range that will not hinder the intended use of the data. The quality assurance/quality control (QA/QC) requirements of this project have been established such that there will be a high degree of confidence in the measurements. Data generated will be equivalent to Analytical Level III in accordance with the United States Environmental Protection Agency (USEPA) guidance document *Data Quality Objectives for Remedial Response Activities,* EPA/540/G-87 /003, *March 1987*.

Data collected during the field investigations will be of sufficient quality to meet DQOs specified herein. The USEPA states that the purpose of the QA/QC program "is the definition of procedures for the evaluation and documentation of sampling and analytical methodologies and the reduction and reporting of data. The objective is to provide a uniform basis for sample collection and handling, instrument and method maintenance, performance evaluation, and analytical data gatherings and reporting." This DCQAP is consistent with the requirements set forth by the USEPA.

The quality of the data resulting from these sampling efforts was designed to be sufficient to characterize concentrations of compounds of concern in and around the Edward Allen Landfill and to monitor performance as a result of the remedial construction. The remainder of this DCQAP describes the specific approaches that will be taken to achieve the required DQOs. Table 1 indicates the frequency of quality control sample collection. Table 2 lists the analytical methods to be used during this program and the corresponding reporting limits. Table 3 lists specific quality control criteria which will be adhered to during sample collection and analyses.

2.2 DATA QUALITY PARAMETERS

The following is a brief description/ definition of data quality parameters that will be used to assess adherence of the data to the DQOs:

- **Representativeness** refers to the degree to which a sample taken from a site accurately reflects the matrix at the site. Representativeness will be achieved by the use of USEPA procedures for the collection and preservation of samples.

- **Comparability** refers to the use of consistent procedures, reporting units, and standardized data format with document control. Adherence to standard procedures maximizes the probability that data generated from a particular method at a given laboratory can be validly compared to the data of another. In addition, in order to assess comparability, reference standards will be analyzed by the laboratory. The concentrations of these standards determined by the laboratory will be compared to the actual values.

- **Completeness** refers to the process of obtaining the required data as outlined in the Operation and Maintenance Manual. Completeness is also defined as the percentage of measurements judged to be valid.

- **Precision** describes the reproducibility of results. It is defined as the agreement between numerical values of two or more measurements that have been made in an identical manner. Precision can be expressed in a variety of manners, including absolute methods such as deviation from the mean or median values, standard deviation and variance, or relative methods, such as relative deviation from the mean or median. Precision will be determined through the analyses of field and laboratory duplicate samples.

- **Accuracy** is a measure of closeness of either an individual measurement or average of a number of measurements to the true value and is expressed in terms of absolute or relative error. Accuracy will be determined through analysis of spiked samples and the analysis of standards with known concentrations.

2.3 DATA QUALITY ASSESSMENT

The Laboratory Quality Assurance Coordinator and the Quality Assurance Officer will be responsible for data assessment. Data quality assessment will be based on instrument tuning criteria, calibration, performance, surrogate recoveries, blanks, and the analysis of quality control samples.

In general, the accuracy of the methods will be determined by spiking the sample matrix with the analyte and by analyzing reference materials with known concentrations. The spiking levels will be selected to reflect the concentration range of interest. Percent recoveries of the spikes and reference materials will be calculated and compared to the limits specified in the analytical methods. The precision of the methods will be determined by the analysis of matrix spike and laboratory and field duplicate samples. The precision will be evaluated by calculating the relative percent difference (RPD) between the duplicates. Relative percent difference calculations will be compared to the limits presented in the analytical methods.

The definitions and equations used for the assessment of data quality are the following:

2.3.1 Accuracy

Accuracy is a measure of the nearness of an analytical result, or a set of results, to the true value. It is usually expressed in terms of. bias, or percent recovery (%R).

Normally the term "accuracy" is used synonymously with "percent recovery". It describes either the recovery of a synthetic standard of known value, or the recovery of known amount of analyte (spike) added to a sample of known value. The %R or "accuracy" can be calculated by using:

1. standards: $\%R = \frac{observed\ value}{true\ value} x\ 100$

2. spikes: $\%R = \frac{(conc.spike+sample)-sample)}{conc.spike} x\ 100$

2.3.2 Precision

Precision refers to the agreement or reproducibility of a set of replicate results among themselves without assumption of any prior information as to the true result. It is usually expressed in terms of the percent difference (%D) or relative percent difference (RPD).

$$\%D = \frac{(larger\ sample\ result) - (smaller\ sample\ result)}{smaller\ sample\ result} x\ 100$$

$$RPD = \frac{|original\ sample\ result - duplicate\ sample\ result|}{\frac{(original\ sample\ result + duplicate\ sample\ result)}{2}} x\ 100$$

2.3.3 Average

The average or arithmetic mean (X) of a set of n values (X_i) is calculated by summing the individual values and dividing by n:

$$X = (\sum X_{i\ \ i=1\ to\ n})/n$$

n = number of values

2.3.4 Range

The range (R_i) is the difference between the highest and lowest value in a group. For n sets of duplicate values (X_2, X_1) the range (R_i) of the duplicates and the average range (R) of the n sets are calculated by:

$$R_i = X_2 \times X_1$$

$$R = \frac{\sum R_{i\ \ i=1\ to\ n}}{n}$$

2.3.5 Standard Deviation and Variation

The standard deviation (S) of a sample of n results is the most widely used measure to describe the dispersion of a data set. It is calculated by using the equation:

$$S = \sqrt{\sum_{i=1}^{n} (Xi - X)^2}$$

Where X is the average of the n results and Xi is the value of result i- Normally, X ± Swill include 68% and X ± 2S about 95% of the data in a normal distribution curve. The variance is equal to S2. The percent relative standard deviation (%RSD) or coefficient of variation (CV) is the standard deviation divided by the mean and multiplied by 100, i.e., CV= 100S/X.

The Laboratory QA Coordinator, with individual laboratory group leaders, will identify any data that should be rated as "unacceptable", based on the assessment of the QA/QC criteria.

3. Sampling and Field measurements

The objective of this section is to document the sampling procedures and practices that will be used during the Operation and Maintenance of the Edward Allen Landfill. The methods that will be used to carry out these activities are detailed in the following subsections.

3.1 SAMPLING AND FIELD MEASUREMENT LOCATIONS

Sampling and field measurement locations will be as indicated in the Operation and Maintenance Manual. Locations include shallow, intermediate, and deep ground water monitoring wells and residential wells and level monitoring in the leachate collection tank. Shallow monitoring wells are OBG-4S, 7S, 14S, and 15S; intermediate monitoring wells are OBG-101, 111, 121, 131 and 151; and deep wells include OBG-4D, 7D, 10D, 11D, 12D, 13D, 14D and 15D. Residential wells include those located on the properties of Allen, Farnham and Rarrick.

An electric water level probe will be used to collect water level measurements in these wells and the leachate collection tank. The probe will be decontaminated between locations. The level should be measured from a consistent reference point (i.e., from a marked point at the top of the PVC well casing) and read to the nearest hundredth when the probe encounters the top of the water.

Surface water samples will be collected from locations designated as SW-1, 2, 3 and 4. Samples of surface water will be collected with either a sampling container or a bottle.

Air monitoring will be performed at the face of the landfill vents and a sample will be collected from the vent with the highest PID reading.

3.2 SAMPLING AND MEASUREMENT RATES

3.3 SAMPLE MATRICES

3.4 SAMPLE TYPES

Ground water sampling will be performed on a quarterly basis for the first year and semi-annually thereafter. Level measurements will be collected from the wells and from the leachate collection tank quarterly for the first year and semi-annually thereafter. Surface water samples will be collected semi-annually following completion of construction. Air monitoring will be conducted on a quarterly basis for the first year following completion of construction. After four rounds of sampling, the data will be reviewed to determine whether further sampling/analysis is necessary. Ground water, surface water and air will be the matrices sampled for the Edward Allen Landfill Operation.

In addition to environmental samples, various types of quality control samples will be collected during sampling events. The following subsections discuss the frequency of collection and purpose of the various quality control samples. Table 1 summaries the frequency of collection of the quality control samples.

3.4.1 Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples

Matrix spike (MS) and matrix spike duplicate (MSD) samples are duplicate samples that have matrix spiking solutions added. The percent recovery of the spiked amount indicates the accuracy and efficiency of the analysis extraction as well as interferences caused by the matrix. Relative percent differences between spike sample recoveries will indicate the precision of the data. MS /MSD samples are to be included for each matrix at a minimum rate of five percent (5%) each. If less than twenty samples are collected during a particular sampling event, then one MS/MSD collection should be performed.

3.4.2 Blank Samples

Field/equipment blanks will consist of samples of distilled/deionized water that is used to rinse the decontaminated sampling equipment. These blanks will be collected at a minimum frequency of five percent (5%) per matrix per set of sampling equipment. The samples will be subjected to the same analyses as the environmental samples.

Trip blanks will consist of samples of distilled/deionized water that have undergone shipment from the sampling site to the laboratory in coolers with samples to be analyzed for volatile organics. Trip blanks will be analyzed for volatile organics to determine if contamination has taken place during sample shipment. A trip blank must accompany every shipment that contains samples for volatile organics analyses.

3.5 SAMPLING PROCEDURES

3.5.1 Ground water sample collection

Prior to ground water sample collection from both on-site and private homeowner well locations, ground water elevation measurements shall be collected using a decontaminated electric probe. Ground water samples shall be collected using a decontaminated bottom-loading, stainless steel bailer attached to a new length of polypropylene rope. The bailer shall be decontaminated between wells as described below. Prior to sample collection, three well volumes of water shall be removed from each well. If the well becomes dry before three volumes of water are removed, the well shall be allowed to recover before the sample is collected.

Prior to submitting the ground water samples for analysis, the turbidity of the water samples shall be measured with a turbidity meter. In accordance with the NYSDEC *Technical and Administrative Guidance Memorandum (TAGM) Policy Regarding Alteration of Ground Water Samples Collected for Metals Analysis,* HWR-88-4015, September 30, 1988, samples submitted for metals analysis shall not be filtered prior to analysis. If the turbidity of the water samples exceeds 50 NTU, NYSDEC shall be contacted to review the circumstances and determine whether filtration of samples for metals analysis would be appropriate. Purge water shall be collected and transferred either directly into the leachate collection tank or into the lift station manhole for transfer to the leachate collection tank.

The following equipment will be required for the sampling and elevation monitoring:

- Electric Water Level Probe

- Bailer with Polypropylene Rope
- Key to Wells
- Key to Gates
- Turbidity Meter
- Sampling Containers
- Chain of Custody Forms
- Bucket
- Field Logs
- Alconox Detergent
- Methanol
- Distilled Water
- Cooler with Ice

3.5.2 Surface Water Sample Collection

Surf ace water sampling will be conducted utilizing a pre-cleaned sampling container or bottle. The sample will be collected from the center of the monitoring location. When collecting the surface water sample the sample container should be emerged into the water with minimal disturbance and/or collection of sediments. The surface water sample monitoring locations are presented on the as-built drawings in Appendix E.

3.5.3 Air Sample Collection

Air monitoring will be conducted utilizing an organic vapor analyzer (OVA), an ultraviolet photoionization detector (PIO), and a combustible gas monitor (CGM). Prior to monitoring activities, each piece of equipment will be calibrated per the manufacturer's instructions. Monitoring will be conducted at the face of the vent opening.

One sample will be collected from the landfill vent which exhibits the highest reading when monitored with a PIO. A one-liter Tedlar bag will be used to collect an air grab sample from the selected vent. The sample will be collected using a peristaltic sampling device, such as a vacuum box or a peristaltic pump, from the center of the vent.

3.5.4 Field Documentation

A field logbook will contain meteorological data, equipment employed during sample collection, equipment calibration information, purging techniques, applicable calculations, ground water elevation data, quantities of water purged from each well, ground water conditions during and after purging, and OVA, PIO and CGM results. Physical characteristics of sample, date, time of day, sample location, and any abnormalities noted during sampling will also be recorded in the field logbook.

3.5.5 Decontamination

A decontamination zone will be established prior to field sampling. Equipment decontamination procedures will take place in the decontamination zone. The decontamination zone will be staffed by person(s) knowledgeable in equipment decontamination procedures. Reusable sampling equipment will be decontaminated as follows. The equipment will be scrubbed with a solution of potable water and Alconox, or equivalent laboratory grade detergent then rinsed with copious quantities of potable water, rinsed with distilled/deionized water then rinsed with methanol. Decontamination fluids and water

purged from the wells will be contained on-site in the leachate collection tank prior to off-site disposal. Information concerning decontamination methodology, dates, times, and personnel will be recorded in the field logbook.

3.6 SAMPLE CONTAINERS

Decontamination wastes will be contained on-site and transferred to the leachate collection tank for disposal. Sample containers will be utilized consistent with the analytical methods specified and with the analytical laboratory's protocol. Sample containers are listed in Table 3.

3.7 SAMPLE PRESERVATION AND HOLDING TIMES

3.8 FIELD CHAIN OF CUSTODY

Samples will be preserved in accordance with the specifications of the analytical methods and with the analytical laboratory's protocol. Sample preservation and holding times are presented in Table 3. Chain of custody procedures will be instituted and followed throughout the investigation. These procedures include field custody, laboratory custody, and evidence files. Samples are physical evidence and will be handled according to strict chain of custody protocol. The National Enforcement Center of the USEPA has defined custody of evidence as follows:

1. in actual possession,
2. in view after being in physical possession,
3. in a locked laboratory, or
4. in a secure, restricted area.

Quality assurance measures for this project will begin with the sample containers. Sample containers will be purchased from a USEPA certified manufacturer and will be pre-cleaned (I-Chem series200 ·or equivalent).

Chain of custody records will be kept starting in the field when sample collection has been completed. In the field logbook, samplers will note meteorological data, equipment employed during collection, evacuation techniques, and applicable calculations. Physical characteristics of sample, date, time of day, sample location, and any abnormalities noted during sampling will be recorded in the field logbook and on the chain of custody form. The sampler will complete the custody form, package the samples into a cooler, place ice in the cooler, and seal the cooler with evidence tape. The chain of custody form will be sealed in a plastic bag and taped to the underside of the cooler lid. Shipment may be made by commercial vendors. The air bill or other appropriate documentation will then be included with laboratory results.

4. Sample Analysis

4.1 LABORATORY CHAIN OF CUSTODY

When the samples arrive at the laboratory, the sample custodian will sign the vendor's air bill or bill of lading (unless hand-delivered). The sample custodian's duties and responsibilities upon sample receipt will be to:

1. document receipt of samples,
2. inspect sample shipping containers for the presence or absence of custody seals, locks, and evidence tape, and for container integrity, 3. sign the appropriate forms or documents,
3. verify and record the agreement or disagreement of information on sample documents and, if there are discrepancies, record the problem and notify the Quality Assurance Officer,
4. label sample with laboratory sample number,
5. check sample pHs, and
6. place samples in secure storage.

A hand-to-hand custody record of samples in the laboratory will be maintained. The analyst will be required to log samples and extracts in and out of storage as the analysis proceeds. Samples and extracts will be returned to secure storage at the close of business. Written records will be kept of each and every time the sample or extract changes hands. The laboratory records may also be used as evidence in enforcement proceedings. Care must be exercised, therefore, to properly complete, date, and sign items needed to generate data.

Copies of the following will be stored for incorporation into the evidence file:

1. documentation of the preparation and analysis of samples, including copies of the analyst's notebooks,
2. bench sheets, graphs, computer printouts, chromatograms, and mass spectra,
3. copies of QA/QC data,
4. instrument logs showing the date, time, and identity of the analyst, and
5. analytical tracking forms that record the date, time, and identity of the analyst for each step of the sample preparation, extraction, and analysis.

4.2 SAMPLE STORAGE AND HOLDING TIMES

Samples will be stored in a secure laboratory sample storage area at 4 °C. The samples will be checked in and out of storage as discussed in Section 4.1. Sample holding times will be adhered to as specified in Table 3.

4.3 SAMPLE PREPARATION METHODS

Samples will be extracted/digested in accordance with the analytical methods prior to introduction into laboratory instrumentation.

4.4 ANALYTICAL PROCEDURES

Laboratory analytical procedures as specified in Table 2 will be performed by a New York State Environmental Laboratory Accreditation Program (ELAP) certified laboratory. EPA method T0-14 will be modified by using a Tedlar bag to collect the air sample as opposed to the SUMMA canister noted in the method. The accuracy and precision of the data generated by the laboratory will be determined through the analysis of duplicate samples, spiked samples, laboratory control samples, and field and laboratory blank samples analyzed along with each set of samples. Interferences will be identified and documented. When matrix interferences are noted during sample analysis, actions will be taken by the laboratory to achieve the specified reporting limits. In such cases, the Laboratory Quality Assurance Coordinator will document that the laboratory demonstrates good analytical practices and that such practices are documented in order to achieve the specified detection limits.

In general, the accuracy of the method will be determined by spiking the sample matrix with analytes and surrogates. Standards and reference materials will also be analyzed to determine analyte concentrations for comparison with expected concentrations and to provide a measure of accuracy of the methods. Percent recoveries of the spikes will be calculated and compared with control limits specified in the analytical methods. A measure of precision will be obtained through the RPD between matrix spikes and matrix spike duplicates for organic compounds and through the RPD of duplicates for metals. Precision will be evaluated based on relative percent difference of duplicate samples. RPDs will be compared to those control limits specified in the analytical methods. The data generated will, whenever possible, be input into the laboratory database management system. When approved and signed, data reports and pertinent information will be reported to Allen Landfill PRP Group.

Table 2 contains reporting limits for the analytical methods that are consistent with the Operation and Maintenance Plan and that contain the compounds of concern.

4.5 CALIBRATION PROCEDURES AND FREQUENCY

Proper calibration of laboratory analytical instrumentation is essential for the generation of reliable data which meets the project's DQOs. Analytical instrument calibration is monitored through the use of control limits which are established for individual analytical methods. Calibration procedures to be followed are specified, in detail, in the analytical methods. These procedures specify the type of calibration, calibration materials to be used, range of calibration, and frequency of calibration.

The analytical laboratory will be responsible for proper calibration and maintenance of laboratory analytical equipment. Calibration procedures, frequencies, and abnormalities will be documented in calibration logbooks for each instrument that requires calibration.

Laboratory specific calibration procedures can be found in the analytical laboratory's Quality Assurance/Quality Control Manual and Standard Operating Procedures (SOPs).

4.6 DATA PRODUCTION, REPORTING, AND VALIDATION

Specific laboratory instrumentation can also be found in the analytical laboratory's Quality Assurance/ Quality Control Manual and SOPs.

4.6.1 Data Production and Reporting

The following instrument specific data production and reporting procedures will be employed at the analytical laboratory.

4.6.1.1 Gas Chromatography (GC)

Output from the GC units will be processed for presentation in two forms:

1. An instrument chromatogram,
2. A post-run integration report containing the following:

    a. Retention time,
    b. Response factors calculated from standards,
    c. Surrogate standard recoveries, and
    d. Listing of all positively identified compounds.

Quality Assurance/Quality Control data such as spikes, spike duplicates, and calibration curves are also processed and stored in post integration reports.

4.6.1.2 Inductively Coupled Plasma Spectrometry (ICP)

This instrumentation will be used for the quantification of some trace metals. Data is directly transmitted to a computer for storage and manipulation. The instrument will be standardized daily for each element to be analyzed. Standardization will be confirmed by analysis of a laboratory control sample that contains each element in question. Continuing calibration standards, interference check standards, blanks, duplicates, and matrix spikes will be analyzed to measure accuracy, precision, and matrix effects. Reduction of data from the analysis of the metals is minimal and consists primarily of tabulating the results and performing basic descriptive statistics on the data.

4.6.1.3 Furnace Atomic Absorption Spectrophotometry

The atomic absorption spectrophotometers will be calibrated using four to five calibration standards. The results of the initial calibration will be used to generate standard curves by least squares fit of the data via computer programs. The deviation of the standards from the least square fit will be printed on the daily printout and the data stored accordingly in appropriate computer bases. If deviations from accepted values occur, analysis of sample and instrumentation calibration will be repeated.

4.6.2 Data Distribution

Following final review by the appropriate Laboratory Quality Assurance Personnel and Manager of Analytical Services, two copies of the results of the analytical determination will be shipped to the Allen Landfill PRP Group.

4.6.3 Reporting

The data report forms will be securely bound, and all pages will be sequentially numbered. The analytical data reports for all samples will include the following information:

1. Case Narrative,
2. Sample Information,
3. Chain of Custody Forms,
4. QC Summary (including **MS/MSD,** QC checks, blanks, system performance, and detection limit information),
5. Sample Data
6. Extraction and Clean-up Log Information.

Review and cross-checking procedures will be per standard operating procedures of the laboratory and will ensure that the raw data and calculation results are properly, completely, and accurately transferred to the laboratory reporting format.

4.6.4 Data Validation

The laboratory data validation process begins with the appropriate laboratory personnel who will review the raw and reduced data for possible calculation and transcription errors. Additionally, these personnel will check unusually high or low parameter values. The Laboratory QA Coordinator will perform a final laboratory validation of the data which will include a review of quality control sample analyses and data completeness. The laboratory report will then be reviewed and approved by the manager of analytical services prior to its release.

4.7 INTERNAL QUALITY CONTROL CHECKS

The number of field QA/QC samples that must be analyzed are listed in Table 1. Method specified QC measures will be followed by the laboratory. Documentation of these QC measures will be maintained. Upon the completion of a sample analysis, the results of QA/QC data will be reviewed to verify compliance with the criteria listed. When results are reported to the Quality Assurance Officer, QA/QC data will be included in the package for review. Matrix spikes, reference standards, laboratory control samples, and surrogates will be used to monitor the accuracy of the methodologies by comparing recoveries to the QA/QC criteria presented in the analytical methods. Matrix spike duplicates and duplicate samples will be incorporated as an indicator of the precision of the sample results. The following subsections discuss the specific QA/QC samples and analyses that the laboratory will utilize.

4.7.1 Blank Analyses

A method blank is a water or soil blank which undergoes all of the preparation procedures applied to a sample (e.g. extraction, digestion). These blanks are analyzed to examine whether sample preparation and analysis techniques result in sample contamination. The laboratory will prepare and analyze a method blank with each sample batch.

Field/equipment blanks will consist of samples of distilled/deionized water that is used to rinse the decontaminated sampling equipment. These blanks will be collected at a minimum frequency of five percent (5%) per matrix per set of sampling equipment. The samples will be subjected to the same analyses as the environmental samples.

Trip blanks will consist of samples of distilled/deionized water that have undergone shipment from the sampling site to the laboratory in coolers with samples to be analyzed for volatile organics. Trip blanks

will be analyzed for volatile organics to determine if contamination has taken place during sample shipment. A trip blank must accompany every shipment that contains samples for volatile organics analyses.

4.7.2 Matrix Spike and Surrogate Compound Analyses

Accuracy and matrix bias are monitored using spiked samples and where possible, surrogate additions. A measured amount of spike/surrogate concentration will be added to the sample before extraction or preparation. The laboratory will prepare and analyze at least one matrix spike for each twenty samples of a particular matrix. Environmental and QC samples will receive surrogate additions, if specified in the analytical method.

4.7.3 Duplicate Sample Analysis

Precision is assessed by the comparison of the results of a sample prepared and analyzed in duplicate. For organic analyses, the laboratory will prepare and analyze a least one matrix spike duplicate for each batch of twenty samples. For inorganic analyses, the laboratory will prepare and analyze at least one duplicate sample for each batch of twenty samples. A laboratory batch will contain samples of only one matrix.

4.8 PREVENTATIVE MAINTENANCE

4.9 CORRECTIVE ACTION

Preventive maintenance procedures will be carried out on field equipment in accordance with the procedures outlined by the manufacturer's equipment manuals. Field equipment (water level probe) used during this project will have a specific maintenance instruction sheet accompanying it. Maintenance activities involving field equipment will be recorded in a field logbook.

A preventive maintenance schedule is followed, and a maintenance log is kept for each laboratory instrument. Instrument downtime will be kept to a minimum, by maintaining service contracts on essential instrumentation and maintaining a supply of critical spare parts. Laboratory staff is experienced in cleaning, maintaining, and troubleshooting instrumentation. Maintenance, whether performed by laboratory or manufacturer personnel, is documented in the appropriate instrument log. Log entries include, the reason for maintenance, maintenance performed, date and initials of person in charge during maintenance.

Corrective action procedures will be implemented based upon detection of data unacceptability. If required, corrective action procedures will be developed on a case-by-case basis. The enacted corrective actions will be documented in the appropriate laboratory notebook, instrument log, or case file.

Generally, the following corrective actions may be taken by the laboratory. When calibration, instrument performance, and blank criteria are not met, the cause of the problem will be located and corrected. The analytical system will then be recalibrated. Sample analysis will not begin until calibration, instrument performance, and blank criteria are met. When matrix spike, reference standard or duplicate analyses are out of control, samples analysis will cease, and the problem will be investigated. Depending on the results of the overall quality control program for the sample set, the

data may be accepted with qualification or rejected. If the laboratory rejects data, those samples will be reprepared and reanalyzed. If matrix interferences are suspected, samples will be subjected to one or more of the clean-up techniques specified in the analytical methods. If QC criteria are met upon reanalysis, only the new results are reported. If quality control criteria are still not met upon reanalysis, both sets of sample results will be reported. The laboratory will make every reasonable effort to correct quality control excursions and to document the presence of matrix interferences. In this way, unnecessary resampling of difficult matrices may be avoided. However, if matrix interferences are not documented resampling may be required.

Corrective actions for the field investigation program, if required, will generally involve altering the incorrect field procedure to match the guidelines set forth in this document. If problems arise with procedures or guidelines set forth in this document, the Quality Assurance Officer and/or the Project Manager will formulate an appropriate corrective action.

5. Summary

The objectives of this DCQAP are to provide sufficiently thorough and concise descriptions of the measures to be applied during operation and maintenance of the Edward Allen Landfill that the data generated thereby will be of a known and acceptable level of precision and accuracy. The quality of data resulting from these sampling efforts was designed to be sufficient to characterize concentrations of compounds of concern in and around the landfill to monitor performance of components of the remedial construction. This DCQAP provides comprehensive information regarding the project description and sets forth specific procedures to be used during sampling of relevant environmental samples, other field activities, and analyses of samples.

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TABLES

Table 1
Quality Control Samples
Edward Allen Landfill
Data Collection Quality Assurance Plan

Quality Control Sample	Frequency of Collection
Laboratory Duplicate	1 per 20 environmental samples (5%) <<or>> 1 per sampling event
Field / Equipment Blank	1 per 20 environmental samples (5%) <<or>> 1 per sampling event
Trip Blank	1 per shipment of samples for Volatile Organics Analysis

Table 2
Reporting Limits
Edward Allen Landfill
Data Collection Quality Assurance Plan

Methods 601 and 602

Analyte	Reporting Limit (ug/L)
Benzene	1.0
Bromodichloromethane	1.0
Bromoform	10.0
Bromomethane	10.0
Carbon Tetrachloride	1.0
Chlorobenzene	1.0
Chloroethane	1.0
2-Chloroethylvinyl ether	10.0
Chloroform	1.0
Chloromethane	10.0
Dibromochloromethane	1.0
1,2-Dichlorobenzene	5.0
1,3-Dichlorobenzene	5.0
1,4-Dichlorobenzene	5.0
Dichlorofluoromethane	10.0
1,1-Dichloroethane	1.0
1,2-Dichloroethane	1.0
1,1-Dichloroethylene	1.0
1,2-Dichloroethylene (total)	1.0
1,2-Dichloropropane	1.0
Ethylbenzene	1.0
cis-1,3-Dichloropropylene	1.0
trans-1,3-Dichloropropylene	1.0
Methylene Chloride	1.0
1,1,2,2-Tetrachloroethane	1.0
Tetrachloroethylene	1.0
Toluene	1.0
1,1,1-Trichloroethane	1.0
1,1,2-Trichloroethane	1.0
Trichloroethylene	1.0
Trichlorofluorimethane	1.0
Vinyl Chloride	1.0
Xylene (Total)	3.0

Table 2
Reporting Limits
Edward Allen Landfill
Data Collection Quality Assurance Plan

Metals

Analyte	Reporting Limit (mg/L)
Aluminum	0.2
Antimony	0.06
Arsenic	0.01
Barium	0.2
Beryllium	0.005
Cadmium	0.005
Hexavalent Chromium	10
Total Chromium	0.01
Cobalt	0.05
Copper	0.025
Iron	0.1
Lead	0.003
Magnesium	5
Mercury	0.0002
Nickel	0.04
Potassium	5
Selenium	0.005
Silver	0.01
Sodium	5
Thallium	0.01
Vanadium	0.05
Zinc	0.02

Table 2
Reporting Limits
Edward Allen Landfill
Data Collection Quality Assurance Plan

Method TP-14 (modified)

Analyte	Reporting Limit (ppb, vol/vol)
Dichlorodifluoromethane (Freon 12)	2.0
Chloromethane	4.0
Vinyl Chloride	2.0
Bromomethane	2.0
Chloroethane	4.0
Trichlorofluoromethane (Freon 11)	2.0
1,1-Dichloroethylene	2.0
Methylene Chloride	2.0
trans-1,2-Dichloroethylene	2.0
1,1-Dichloroethane	2.0
cis-1,2-Dichloroethylene	2.0
Chloroform	2.0
1,1,1-Trichloroethane	2.0
Carbon Tetrachloride	2.0
Benzene	2.0
1,2-Dichloroethane	2.0
Trichloroethylene	2.0
1,2-Dichloropropane	2.0
Toluene	2.0
trans-1,3-dichloropropane	2.0
Tetrachloroetheylene	2.0
Dibromochloromethane	2.0
Chlorobenzene	2.0
Ethylbenzene	2.0
Total Xylenes	2.0
Bromoform	2.0
1,1,2,2-Tetrachloroethane	2.0
1,3-Dichlorobenzene	2.0
1,4-Dichlorobenzene	2.0
1,2-Dichlorobenzene	2.0

Table 3
Sample Containers, preservations, and holding times
Edward Allen Landfill
Data Collection Quality Assurance Plan

Analysis	Media	Sample Containlers	Preservation	Holding Time
Volatile Organics	Aqueous	2 x 40 ml glass, Teflon Septum	Cool to 4 degrees C	7 days
	Air	1 liter Tedlar Bag	Cool to 4 degrees C	7 days
Metals	Aqueous	1 liter Polyethylene	HNO3 to pH < 2, then cool to 4 degrees C	6 months
Hexavalent Chromium	Aquueous	1 liter Polyethylene	Cool to 4 degrees C	24 hours

Table 4
Quality Control Requirements
Edward Allen Landfill
Data Collection Quality Assurance Plan

Volatile Organics USEPA Methods 601 and 602

Audit	Frequency	Control Limits	Corrective Action
Initial Calibration	Prior to sample analysis and when continuing calibration criteria are not met.	Three concentrations bracketing the expected concentration range for compound of interest. RSD criteria listed in the method must be met, otherwise calibration curve must be used for quantitation.	1. Identify and correct the problem 2. If Criteria are still not met, recalibrate 3. Document corrective action - samples cannot be analyzed until calibration control limit criteria are met.
Continuing Calibration	Daily	Wihtin the method specified	1. Reanalyze 2. If Criteria are still not met, identify and correct problem, recalibrate 3. Document corrective action - samples cannot be analyzed until calibration control limit criteria are met.
Method Blank Analysis	Prior to sample analysis; every 20 samples; and with each analytical batch	Less than the Reporting Limit	1. Reanalyze 2. If limits are still exceeded, clean instrument and recalibrate analytical system. 3. Document corrective action - samples cannot be analyzed until blank criteria are met.
Field / Equipment Blank Analysis	Every 20 samples	Less than the Reporting Limit	1. Investigate Problem 2. Write an explanation
Laboratory Control Sample Analysis	1 in 10 samples; or each analytical batch (whichever is more frequent)	Recovery within the laboratory control limits	1. Reanalyze and examine results of other QC analyses 2. If recovery is still outside limits, and other QCX criteria are met, prepare new LCS, re-extract and re-analyze 3. If other QC criteria are not met, stop analysis, locate and correct problem, recalibrate instrument and reanalyze sasmples since last satisfactgory LCS.
Surrogate Spike	All samples and blanks (including MS/MSD)	Recovery within the laboratory control limits	1. Reanalyze 2. If receovery is still outside limits, qualify data. 3. Document corrective action
Matrix Spike (MS) and Matrix Spike Duplicate (MSD) Analysis	1 per group of similar concentration and matrix; 1 per case of samples; or 1 in 20	Recovery within the laboratory control limits	1. Reanalyze 2. If receovery is still outside limits, qualify data. 3. Document corrective action
Laboratory Duplicate Analysis	1 per group of similar concentration and matrix; 1 per case of samples; or 1 in 20 (whichever is greater)	Recovery within the laboratory control limits	1. Investigate the problem and re-extrat or re-analyze 2. Document corrective action
Field Duplicate Analysis	1 per matrix and analytical batch and every 20 samples of similar matrix	50% RPD for waters; 100% RPD for soils	If these criteria are not met, sample results will be evaluated on a case by case basis
Trip Blanks	1 per shipment of samples	Less than the Reporting Limit	1. Investigate the problem 2. Write an explanation

Table 4
Quality Control Requirements
Edward Allen Landfill
Data Collection Quality Assurance Plan

Volatile Organics USEPA Methods 200.7, 206.2, 239.2, 245.1 and 270.2

Audit	Frequency	Control Limits	Corrective Action
Calibration Verification	Calibrate daily and each time instrument is set up; verify at more frequent of 10% or each 2 hours	Within laboratory control limits	1. Reanalyze 2. If Criteria are still not met, identify and correct the problem, recalibrate 3. Document corrective action - samples cannot be analyzed until calibration control limit criteria are met.
Calibration Blank	At the beginning and end of run and at a rate of 10% during run	Less than the Reporting Limit	1. Identify and correct the problem. 2. If Criteria are still not met, recalibrate 3. Document corrective action - samples cannot be analyzed until calibration control limit criteria are met.
Preparation of Blank Analysis	1 per bsatch of samples digested; or 1 in 20 (whichever is greater)	Less than the Reporting Limit	1. Reanalyze 2. If limits are still exceeded, clean instrument and recalibrate analytical system. 3. Document corrective action - samples cannot be analyzed until blank criteria are met.
Method Blank Analysis	Prior to sample analysis; every 20 samples; and with each analytical batch	Less than the Reporting Limit	1. Reanalyze 2. If limits are still exceeded, clean instrument and recalibrate analytical system. 3. Document corrective action - samples cannot be analyzed until blank criteria are met.
Field / Equipment Blank Analysis	Every 20 samples	Less than the Reporting Limit	1. Investigate Problem 2. Write an explanation
Reagent Blank	1 in 10 samples; or each analytical batch (whichever is more frequent)	Recovery within the laboratory control limits	1. Reanalyze 2. If recovery is still outside control limits, qualify the data 3. Document the corrective action.
Laboratory Control Sample Analysis	1 in 20 samples	Recovery within the laboratory control limits	1. Reanalyze and examine results of other QC analyses 2. If recovery is still outside limits, and other QCX criteria are met, prepare new LCS, re-extract and re-analyze 3. If other QC criteria are not met, stop analysis, locate and correct problem, recalibrate instrument and reanalyze sasmples since last satisfactgory LCS. 4. Document corrective action.
Matrix Spike (MS) and Matrix Spike Duplicate (MSD) Analysis	1 per group of similar concentration and matrix; 1 per case of samples; or 1 in 20	Recovery within the laboratory control limits	1. Reanalyze 2. If recovery is still outside limits, qualify data. 3. Document corrective action
Laboratory Duplicate Analysis	1 per group of similar concentration and matrix; 1 per case of samples; or 1 in 20 (whichever is greater)	Recovery within the laboratory control limits	1. Investigate the problem and re-extrat or re-analyze 2. Document corrective action
Field Duplicate Analysis	1 per matrix and analytical batch and every 20 samples of similar matrix	50% RPD for waters; 100% RPD for soils	If these criteria are not met, sample results will be evaluated on a case by case basis
Furnace Analysis	Every sample must be injected in duplicate and spiked; method of standard addition is required when sample absorbance or concentration >= 50% of spike concentration and % recovery is not within the control limits	Recovery and RSD within method requriements.	1. Reanalyze 2. If limits are still exceeded, qualify the data 3. Document corrective action
Interference Check Sample	An ICS A and B must be analyzed at the beginning and end of each sample analysis run or at a minimum of twice per 8 hours, whichever is more frequent.	Recovery wtihin +/- 20% of the true value. Analytes not present in ICS A solution must be within _/- reporting limit concentration	1. Reanalyze 2. If criteria are sill not met, identify and correct the problem, re-calibrate 3. Document corrective action. Samples cannot be analyzed until ICS control limits have been met.

APPENDIX D

Details of Calculation on Data Evaluation

16.3.3 Intervention Analysis and Box-Jenkins Models

If a long time sequence of equally spaced data is available, intervention analysis may be used to detect changes in average level resulting from a natural or man-induced intervention in the process. This approach, developed by Box and Tiao (1975), is a generalization of the autoregressive integrated moving-average (ARIMA) time series models described by Box and Jenkins (1976). Lettenmaier and Murray (1977) and Lettenmaier (1978) study the power of the method to detect trends. They emphasize the design of sampling plans to detect impacts from polluting facilities. Examples of its use are in Hipel et al. (1975) and Roy and Pellerin (1982).

Box-Jenkins modeling techniques are powerful tools for the analysis of time series data. McMichael and Hunter (1972) give a good introduction to Box-Jenkins modeling of environmental data, using both deterministic and stochastic components to forecast temperature flow in the Ohio River. Fuller and Tsokos (1971) develop models to forecast dissolved oxygen in a stream. Carlson, MacCormick, and Watts (1970) and McKerchar and Delleur (1974) fit Box-Jenkins models to monthly river flows. Hsu and Hunter (1976) analyze annual series of air pollution SO_2 concentrations. McCollister and Wilson (1975) forecast daily maximum and hourly average total oxidant and carbon monoxide concentrations in the Los Angeles Basin. Hipel, McLeod, and Lennox (1977*a*, 1977*b*) illustrate improved Box-Jenkins techniques to simplify model construction. Reinsel et al. (1981*a*, 1981*b*) use Box-Jenkins models to detect trends in stratospheric ozone data. Two introductory textbooks are McCleary and Hay (1980) and Chatfield (1984). Box and Jenkins (1976) is recommended reading for all users of the method.

Disadvantages of Box-Jenkins methods are discussed by Montgomery and Johnson (1976). At least 50 and preferably 100 or more data collected at equal (or approximately equal) time intervals are needed. When the purpose is forecasting, we must assume the developed model applies to the future. Missing data or data reported as trace or less-than values can prevent the use of Box-Jenkins methods. Finally, the modeling process is often nontrivial, with a considerable investment in time and resources required to build a satisfactory model. Fortunately, there are several packages of statistical programs that contain codes for developing time series models, including Minitab (Ryan, Joiner, and Ryan 1982), SPSS (1985), BMDP (1983), and SAS (1985). Codes for personal computers are also becoming available.

16.4 MANN-KENDALL TEST

In this section we discuss the nonparametric Mann-Kendall test for trend (Mann, 1945; Kendall, 1975). This procedure is particularly useful since missing values are allowed and the data need not conform to any particular distribution. Also, data reported as trace or less than the detection limit can be used (if it is acceptable in the context of the population being sampled) by assigning them a common value that is smaller than the smallest measured value in the data set. This approach can be used because the Mann-Kendall test (and the seasonal Kendall test in Chapter 17) use only the relative magnitudes of the data rather

than their measured values. We note that the Mann-Kendall test can be viewed as a nonparametric test for zero slope of the linear regression of time-ordered data versus time, as illustrated by Hollander and Wolfe (1973, p. 201).

16.4.1 Number of Data 40 or Less

If n is 40 or less, the procedure in this section may be used. When n exceeds 40, use the normal approximation test in Section 16.4.2. We begin by considering the case where only one datum per time period is taken, where a time period may be a day, week, month, and so on. The case of multiple data values per time period is discussed in Section 16.4.3.

The first step is to list the data in the order in which they were collected over time: $x_1, x_2, \ldots, x_n$, where x_i is the datum at time i. Then determine the sign of all $n(n-1)/2$ possible differences $x_j - x_k$, where $j > k$. These differences are $x_2 - x_1, x_3 - x_1, \ldots, x_n - x_1, x_3 - x_2, x_4 - x_2, \ldots, x_n - x_{n-2}, x_n - x_{n-1}$. A convenient way of arranging the calculations is shown in Table 16.1.

Let $\text{sgn}(x_j - x_k)$ be an indicator function that takes on the values 1, 0, or -1 according to the sign of $x_j - x_k$:

$$\begin{aligned} \text{sgn}(x_j - x_k) &= 1 \quad \text{if } x_j - x_k > 0 \\ &= 0 \quad \text{if } x_j - x_k = 0 \\ &= -1 \quad \text{if } x_j - x_k < 0 \end{aligned} \tag{16.1}$$

Then compute the Mann-Kendall statistic

$$S = \sum_{k=1}^{n-1} \sum_{j=k+1}^{n} \text{sgn}(x_j - x_k) \tag{16.2}$$

which is the number of positive differences minus the number of negative differences. These differences are easily obtained from the last two columns of Table 16.1. If S is a large positive number, measurements taken later in time tend to be larger than those taken earlier. Similarly, if S is a large negative number, measurements taken later in time tend to be smaller. If n is large, the computer code in Appendix B may be used to compute S. This code also computes the tests for trend discussed in Chapter 17.

Suppose we want to test the null hypothesis, H_0, of no trend against the alternative hypothesis, H_A, of an upward trend. Then H_0 is rejected in favor of H_A if S is positive and if the probability value in Table A18 corresponding to the computed S is less than the a priori specified α significance level of the test. Similarly, to test H_0 against the alternative hypothesis H_A of a downward trend, reject H_0 and accept H_A if S is negative and if the probability value in the table corresponding to the absolute value of S is less than the a priori specified α value. If a two-tailed test is desired, that is, if we want to detect either an upward or downward trend, the tabled probability level corresponding to the absolute value of S is doubled and H_0 is rejected if that doubled value is less than the a priori α level.

EXAMPLE 16.1

We wish to test the null hypothesis H_0, of no trend versus the alternative hypothesis, H_A, of an upward trend at the $\alpha = 0.10$

average rank of 2, which would not have changed the value of W_{rs}. If NDs occur in both populations, they can be treated as tied values all less than the smallest numerical value in the combined data set. Hence, they would each receive the average rank value for that group of NDs, and the Wilcoxon test could still be conducted. (See Exercise 18.4.)

18.2.2 Kruskal-Wallis Test

The Kruskal-Wallis test is an extension of the Wilcoxon rank sum test from two to k independent data sets. These data sets need not be drawn from underlying distributions that are normal or even symmetric, but the k distributions are assumed to be identical in shape. A moderate number of tied and ND values can be accommodated. The null hypothesis is

H_0: The populations from which the k data sets have been drawn have the same mean **18.10**

The alternative hypothesis is

H_A: At least one population has a mean larger or smaller than at least one other population **18.11**

The data take the form

Population				
1	*2*	*3*	· · ·	*k*
x_{11}	x_{21}	x_{31}	· · ·	x_{k1}
x_{12}	x_{22}	x_{32}	· · ·	x_{k2}
⋮	⋮	⋮	⋮ ⋮ ⋮	⋮
x_{1n_1}	x_{2n_2}	x_{3n_3}		x_{kn_k}

The total number of data is $m = n_1 + n_2 + \cdots + n_k$, where the n_i need not be equal. The steps in the testing procedure are as follows:

1. Rank the m data from smallest to largest, that is, assign the rank 1 to the smallest datum, the rank 2 to the next largest, and so on. If ties occur, assign the midrank (illustrated in Example 18.5). If NDs occur, treat these as a group of tied values that are less than the smallest numerical value in the data set (assuming the detection limit of the ND values is less than the smallest numerical value).
2. Compute the sum of the ranks for each data set. Denote this sum for the jth data set by R_j.
3. If there are no tied or ND values, compute the Kruskal-Wallis statistic as follows:

$$K_w = \left[\frac{12}{m(m+1)}\sum_{j=1}^{k}\frac{R_j^2}{n_j}\right] - 3(m+1) \qquad \textbf{18.12}$$

4. If there are ties or NDs treated as ties, compute a modified Kruskal-Wallis statistic by dividing K_w (Eq. 18.12) by a correction for ties, that is, compute

$$K'_w = \frac{K_w}{1 - \dfrac{1}{m(m^2-1)} \sum_{j=1}^{g} t_j(t_j^2 - 1)} \qquad 18.13$$

where g is the number of tied groups and t_j is the number of tied data in the jth group. Equation 18.13 reduces to Eq. 18.12 when there are no ties.

5. For an α level test, reject H_0 and accept H_A if $K'_w \geq \chi^2_{1-\alpha,k-1}$, where $\chi^2_{1-\alpha,k-1}$ is the $1 - \alpha$ quantile of the chi-square distribution with $k - 1$ df, as obtained from Table A19, where k is the number of data sets. Iman, Quade, and Alexander (1975) provide exact significance levels for the following cases:

$$k = 3 \quad n_i \leq 6$$
$$n_1 = n_2 = n_3 = 7$$
$$n_1 = n_2 = n_3 = 8$$
$$k = 4 \quad n_i \leq 4$$
$$k = 5 \quad n_i \leq 3$$

Less extensive exact tables are given in Conover (1980) and Hollander and Wolfe (1973) for $k = 3$ data sets.

EXAMPLE 18.5

An aliquot-size variability study is conducted in which multiple soil aliquots of sizes 1 g, 10 g, 25 g, 50 g, and 100 g are analyzed for ^{241}Am. A portion of the data for aliquot sizes 1 g, 25 g, and 100 g is used in this example. (Two ND values are added for illustration.) The full data set is discussed by Gilbert and Doctor (1985). We test the null hypothesis that the concentrations from all 3 aliquot sizes have the same mean. The alternative hypothesis is that the concentrations for at least 1 aliquot size tend to be larger or smaller than those for at least 1 other aliquot size. We test at the $\alpha = 0.05$ level. The data, ranks, and rank sums are given in Table 18.6.

Table 18.6 Aliquot-Size Variability Study

^{241}Am Concentrations (nCi/g)		
1 g	*25 g*	*100 g*
1.45 (7)[a]	1.52 (8.5)	1.74 (13)
1.27 (6)	2.46 (22)	2.00 (17.5)
1.17 (4)	1.23 (5)	1.79 (14)
1.01 (3)	2.20 (20)	1.81 (15)
2.30 (21)	2.68 (23)	1.91 (16)
1.54 (10)	1.52 (8.5)	2.11 (19)
1.71 (11.5)	ND (1.5)	2.00 (17.5)
1.71 (11.5)		
ND (1.5)		
$R_1 = 75.5$	$R_2 = 88.5$	$R_3 = 112$
$n_1 = 9$	$n_2 = 7$	$n_3 = 7$

[a]Rank of the datum.
ND = not detected.

Step 3. Within each month and year, subtract the average monthly concentration for that month and add the grand mean. For example, for January 1983, the adjusted concentration becomes

$$1.99 - 2.05 + 2.17 = 2.11$$

The adjusted concentrations are shown in the last three columns of Table 7-1.

The reader can check that the average of all 36 adjusted concentrations equals 2.17, the average unadjusted concentration. Figure 7-1 shows the plot of the unadjusted and adjusted data. The raw data clearly exhibit seasonality as well as an upwards trend which is less evident by simply looking at the data table.

INTERPRETATION

As can be seen in Figure 7-1, seasonal effects were present in the data. After adjusting for monthly effects, the seasonality was removed as can be seen in the adjusted data plotted in the same figure.

7.3 COMBINED SHEWHART-CUSUM CONTROL CHARTS FOR EACH WELL AND CONSTITUENT

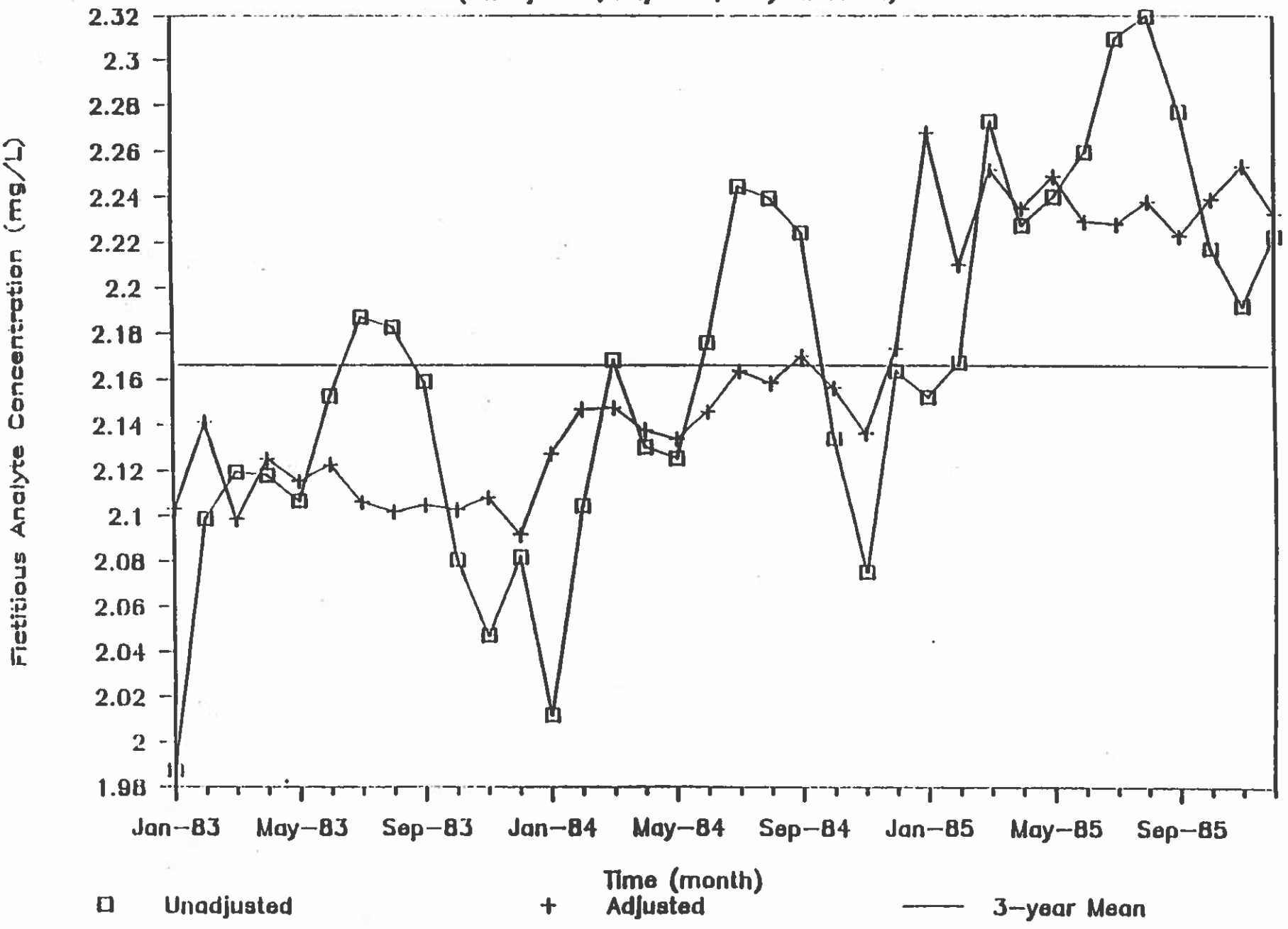
Control charts are widely used as a statistical tool in industry as well as research and development laboratories. The concept of control charts is relatively simple, which makes them attractive to use. From the population distribution of a given variable, such as concentrations of a given constituent, repeated random samples are taken at intervals over time. Statistics, for example the mean of replicate values at a point in time, are computed and plotted together with upper and/or lower predetermined limits on a chart where the x-axis represents time. If a result falls outside these boundaries, then the process is declared to be "out of control"; otherwise, the process is declared to be "in control." The widespread use of control charts is due to their ease of construction and the fact that they can provide a quick visual evaluation of a situation, and remedial action can be taken, if necessary.

In the context of ground water monitoring, control charts can be used to monitor the inherent statistical variation of the data collected within a single well, and to flag anomalous results. Further investigation of data points lying outside the established boundaries will be necessary before any direct action is taken.

A control chart that can be used on a real time basis must be constructed from a data set large enough to characterize the behavior of a specific well. It is recommended that data from a minimum of eight samples within a year be collected for each constituent at each well to permit an evaluation of the consistency of monitoring results with the current concept of the hydrogeology of the site. Starks (1988) recommends a minimum of four sampling periods at a unit with eight or more wells and a minimum of eight sampling periods at a unit with less than four wells. Once the control chart for the specific constituent at a given well is acceptable, then subsequent data

Time Series of Monthly Observations

(Unadjusted, Adjusted, 3-year Mean)



points can be plotted on it to provide a quick evaluation as to whether the process is in control.

The standard assumptions in the use of control charts are that the data generated by the process, when it is in control, are independently (see Section 2.4.2) and normally distributed with a fixed mean μ and constant variance σ^2. The most important assumption is that of independence; control charts are not robust with respect to departure from independence (e.g., serial correlation, see glossary). In general, the sampling scheme will be such that the possibility of obtaining serially correlated results is minimized, as noted in Section 2. The assumption of normality is of somewhat less concern, but should be investigated before plotting the charts. A transformation (e.g., log-transform, square root transform) can be applied to the raw data so as to obtain errors normally distributed about the mean. An additional situation which may decrease the effectiveness of control charts is seasonality in the data. The problem of seasonality can be handled by removing the seasonality effect from the data, provided that sufficient data to cover at least two seasons of the same type are available (e.g., 2 years when monthly or quarterly seasonal effect). A procedure to correct a time series for seasonality was shown above in Section 7.2.

PURPOSE

Combined Shewhart-cumulative sum (CUSUM) control charts are constructed for each constituent at each well to provide a visual tool of detecting both trends and abrupt changes in concentration levels.

PROCEDURE

Assume that data from at least eight independent samples of monitoring are available to provide reliable estimates of the mean, μ, and standard deviation, σ, of the constituent's concentration levels in a given well.

Step 1. To construct a combined Shewnart-CUSUM chart, three parameters need to be selected prior to plotting:

h - a decision internal value
k - a reference value
SCL - Shewnart control limit (denoted by U in Starks (1988))

The parameter k of the CUSUM scheme is directly obtained from the value, D, of the displacement that should be quickly detected: k = D/2. It is recommended to select k = 1, which will allow a displacement of two standard deviations to be detected quickly.

When k is selected to be 1, the parameter h is usually set at values of 4 or 5. The parameter h is the value against which the cumulative sum in the CUSUM scheme will be compared. In the context of groundwater monitoring, a value of h = 5 is recommended (Starks, 1988; Lucas, 1982).

The upper Shewhart limit is set at SCL = 4.5 in units of standard deviation. This combination of k = 1, h = 5, and SCL = 4.5 was found most appropriate for the application of combined Shewhart-CUSUM charts for groundwater monitoring (Starks, 1988).

Step 2. Assume that at time period T_i, n_i concentration measurements $X_1, \ldots, X_{ni}$, are available. Compute their average $\bar{X}_i$.

Step 3. Calculate the standardized mean

$$Z_i = (\bar{X}_i - \mu) \sqrt{n_i}/\sigma$$

where μ and σ are the mean and standard deviation obtained from prior monitoring at the same well (at least four sampling periods in a year).

Step 4. At each time period, T_i, compute the cumulative sum, S_i, as:

$$S_i = \max \{0, (Z_i - k) + S_{i-1}\}$$

where max {A, B} is the maximum of A and B, starting with $S_0 = 0$.

Step 5. Plot the values of S_i versus T_i on a time chart for this combined Shewhart-CUSUM scheme. Declare an "out-of-control" situation at sampling period T_i if for the first time, $S_i \geq h$ or $Z_i \geq SCL$. This will indicate probable contamination at the well and further investigations will be necessary.

REFERENCES

Lucas, J. M. 1982. "Combined Shewhart-CUSUM Quality Control Schemes." *Journal of Quality Technology*. Vol. 14, pp. 51-59.

Starks, T. H. 1988 (Draft). "Evaluation of Control Chart Methodologies for RCRA Waste Sites."

Hockman, K. K., and J. M. Lucas. 1987. "Variability Reduction Through Subvessel CUSUM Control." *Journal of Quality Technology*. Vol. 19, pp. 113-121.

EXAMPLE

The procedure is demonstrated on a set of carbon tetrachloride measurements taken monthly at a compliance well over a 1-year period. The monthly means of two measurements each (n_i = 2 for all i's) are presented in the third column of Table 7-2 below. Estimates of μ and σ, the mean and standard deviation of carbon tetrachloride measurements at that particular well were obtained from a preceding monitoring period at that well; μ = 5.5 µg/L and σ = 0.4 µg/L.