# Appendix F

## Interim Abandonment & Restoration Plan

Environment Canada Environnement Canada

# INTERIM ABANDONMENT & RESTORATION PLAN

## - Eureka High Arctic Weather Station –

In support of the

Nunavut Water Board License

No. 8BC-EUR1621

Public Service and Procurement Canada (PSPC)

June 2021

Canada

# CONTROL PAGE

On receipt of revisions and/or amendments, this control page will be updated to ensure that the Interim Abandonment & Restoration Plan is always current and consistently reflects the operations and activities taking place on site.

| Revision Number | Date Inserted | Description | Signature |
|---|---|---|---|
| 1 | Dec. 2010 | Modified closure planning timelines and included temporary closure SOPs | |
| 2 | June 2021 | Under Part I, Item 1, "this revision is to include sections on the closure of temporary facilities including at a minimum:<br>a. Further updates on the plans for reclamation of infrastructure and waste materials associated with the Department of National Defence (DND) as indicated in Addendum 1 of the 2011 Interim A&R Plan;<br>b. An A&R Plan for the Blacktop Creek quarry and mobile wash-car; and<br>c. An A&R for the Construction Worker Camp. | |
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# APPENDICES



# ACRONYMS AND SYMBOLS

| | |
|---|---|
| AEC | Areas of Environmental Concern |
| CCME | Canadian Council of Ministers of the Environment |
| CIRNAC | Crown-Indigenous Relations and Northern Affairs Canada |

| | |
|---|---|
| DND | Department of National Defence |
| EA | Environmental Assessment |
| ECCC | Environment and Climate Change Canada |
| HAWS | High Arctic Weather Station |
| M | Cubic metre |
| NRC | National Research Council Canada |
| NWB | Nunavut Water Board |
| ODS | Oxygen Depleting Substances |
| PCB | Polychlorinated Biphenyls |
| PHC | Petroleum Hydrocarbons |
| POL | Petroleum, Oil, Liquids |
| PSPC | Public Services and Procurement Canada |
| RAP | Remedial Action Plan |
| SOP | Standard Operating Procedure |
| SSHHERA | Site Specific Human Health and Ecological Risk Assessment |
| SSTL | Site Specific Target Levels |
| The Plan | Interim Abandonment and Restoration Plan |

# PART I: INTRODUCTION:

## BACKGROUND:

All facilities must eventually cease their activities, either temporarily or permanently. When such operations cease, the owner and operator must close the facility in a way that ensures it will not pose a future threat to human health and the environment. Therefore, an Abandonment and Restoration Plan is used to achieve “clean closure.”

## PURPOSE:

The purpose of this interim Abandonment and Restoration Plan (the Plan) is to provide:

- Conceptual detail on the reclamation of the components of the Eureka High Arctic Weather Station (HAWS; the Site) which will not be closed until near the end of its useful life; and

- Operational detail for components which are to be progressively reclaimed now or in the near future.

## APPROACH TO PLAN:

The approach taken to develop this Plan is underpinned by the Environment and Climate Change Canada’s (ECCC) commitment to the following global objectives:

- Physical Stability: remaining items will be constructed or modified at closure to be physically stable such that they do not erode, subside or move from their intended location.

- Chemically Stability: remaining items will be chemically stable; the remaining chemical constituents should not endanger public, wildlife or environmental health and safety.

- Future Use and Aesthetics: the Site will be compatible with the surrounding lands once abandonment activities have been completed.

The specific actions of the Plan to remediate each of the facility components are, in turn, based on more detailed objectives formulated to achieve the above global intentions. The Plan is an evolutionary document and thus reclamation activities will be more fully described as new information is made available from progressive restoration activities (and associated studies), associated environmental assessments and monitoring results of the aforementioned restoration activities.

The following considerations were considered in the development, evolution, and implementation of the Plan:

- Respect all historical agreements and obligations in a fair manner;
- Ensure consistency with federal guidelines, including Site Specific Target Levels (SSTLs) for Eureka HAWS, for the management of contaminated sites;
- Apply simple, practical remedial solutions wherever possible, with flexibility as necessary to adjust to site-specific conditions when they become evident;
- Take into account the warming of the Arctic; and
- Directions from the Nunavut Water Board (NWB) and inspection reports provided by the Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC).

# PART II: SITE DESCRIPTION

The Eureka HAWS is located on the north side of Slidre Fjord, at the northwestern tip of Fosheim Peninsula on Ellesmere Island, Nunavut at site coordinates 79°59'41"N and 85$^0$48'48"W.

The total area of the occupied Site is approximately 2.23 hectares.

## BIOPHYSICAL ENVIRONMENT

### PHYSIOGRAPHIC DESCRIPTION:

The Eureka HAWS is located in the Eureka Hills Eco-region, within the Northern Arctic Ecozone and the topography of the area is rolling and ridged, reaching altitudes of no more than 1000 m above sea level.

Soils in the Site area are primarily a sand/gravel fill underlain by silty, sandy clays. Permafrost is present with an active layer ranging between 0.6 and 1.2 m in thickness.

### CLIMATE

The climate is cold and dry and mean annual temperatures range from -30$^0$C in winter to 0.5$^0$C in summer. Annual precipitation ranges between 50 to 150 mm. The prevailing winds are from the west.

### FAUNA

Fauna include muskoxen, polar bears, wolverines, arctic wolves, arctic foxes, arctic hares, and lemmings. In addition, summer nesting geese, ducks, owls, loons, ravens, gulls and many other smaller birds nest, raise their young and return south in August.

## CURRENT ENVIRONMENTAL CONDITIONS

A study conducted in 2006 (NRC) provided a list of sites with the highest contamination levels and/or sites which had 100% of their respective samples test above Canadian Council of Ministers of the Environment (CCME) guideline criteria. These sites were:

- North Airstrip Apron
- Sewage Lagoon
- Barrel Dump

A 2007 Phase I Environmental Site Assessment identified the following at Eureka HAWS:

- 16 areas of potential environmental concern

- Potentially contaminated environmental media identified at:
  - Fuel tank farm (old and new)
  - Powerhouse
  - DND warehouse fuel tank vicinity
  - Bulky debris landfill east of airstrip

A 2009 Phase III Environmental Site Assessment identified the following at Eureka HAWS:

- 16 initial areas of potential environmental concern have been reduced to 6 Areas of Environmental Concern (AEC) which require further work and/or investigation including:
  - AEC A-7 Ex-Situ Biotreatment Cell
  - AEC B-1 Fuel Tank Farm
  - AEC B-2 In-Situ Landfarm
  - AEC D-1 Powerhouse
  - AEC E-1 Hydrogen Building

In 2012, and updated in 2021, AECOM Canada Ltd. (AECOM 2021) completed hazardous and non-hazardous waste surveys on 10 buildings and associated infrastructure located at the Eureka HAWS, to support the upcoming building deconstruction project. The surveys included the following:

- Visual inspection, quantity estimates (hazardous and non-hazardous items) and sample collection of potentially hazardous building materials.
- Hazardous building materials assessed included asbestos containing materials, lead amended paints, leachable lead containing paints, polychlorinated biphenyls (PCBs) in paints and electrical equipment, ozone depleting substances (ODS) and mercury containing items.
- The audit estimated a total of 1,996 cubic metres (m3) of non-hazardous waste and a volume of 184 m3 of hazardous waste would be generated from the building deconstruction project.

An Environmental Impact Assessment was undertaken in 2015 (Arcadis 2016) and again in 2018 (Arcadis 2018) which confirmed that adherence to regulations and implementation measures will help ensure that activities occurring at the Site do not cause significant adverse effects on the environment.

A Remedial Action Plan (RAP) was prepared by Dillon Consulting Limited and Outcome Consultants in joint venture (Dillon-Outcome 2021a) for contaminated soil that will be affected

by the upcoming and on-going construction projects at Eureka HAWS, as well as contaminated soils in areas that were intended to be remediated when it would be efficient to do so (embankment by the Powerhouse and Drainage Pond). The RAP identified the following:

- Using newly-derived SSTLs, which were developed from the Site Specific Human Health and Ecological Risk Assessment (SSHHERA), approximately 9,500 m3 of contaminated soil will require management as a result of planned construction projects.
- A remedial options analysis was completed, which concluded that excavation and on-Site landfarm treatment was the most favorable option for the contaminated soils.
- Once treated to the SSTLs, the soil could be used as general, industrial backfill on-Site.
- To improve the certainty of contaminated soil volume estimates and contaminated soil management requirements for the construction projects, a data gap sampling program was recommended.

A SSHHERA was undertaken in 2021 (Dillon-Outcome 2021b) which concluded:

- There are no risks to people engaging in any types of work activities at the Site.
- PHC F2 contamination at the Site has the potential to cause adverse effects on plants; however, given the area of contamination versus the rest of the Site area, the changes of population effects on plants is low.
- PHC F2 concentrations are expected to decrease through natural attenuation over time which also would reduce any potential impacts.
- Wildlife are not at risk from exposure to contamination at the Site.
- Water quality in the drainage pond and stream area does not result in adverse effects on the aquatic community.
- There is potential for sediment impacts in the benthic community down slope of the powerhouse building. Minor Adverse effects may be overserved just after the berm within the stream area.
- SSTLs were developed to aid in any remedial planning at the Site. Contaminants of potential concern include arsenic, boron, copper, lead, zinc, PHC F1, PHC F2, PHC F3, and Naphthalene.

## CURRENT PERMITS, LICENCES HELD

The current permits and licenses held are listed below and contained in Appendix A:

- Land Use Permit N2017N0017 (2017)
- Amended Land Use Permit N2017N0017 (2018)
- Quarry Permit 2018QP0001
- Quarry Permit 2020QP0002
- Type ‘B’ Water Licence 8BC-EUR1621 (2016)
- Amended Water Licence 8BC-EUR1621 / Amendment No. 1 (2018)

# PART III: THE PLAN

The Plan consists of the following elements:

1. Specific abandonment and restoration objectives and actions to be taken to achieve those objectives for each of the facility components for both temporary and permanent closure;
2. Details of measures to be employed for progressive restoration;
3. Monitoring program to be employed in recording the success of on-going restoration activities;
4. Description of the final landscape and how aesthetic concerns will be factored into the restoration process; and
5. Post-closure treatment potentially required for drainage water that is not acceptable for discharge.

## TEMPORARY CLOSURE

In the context of Eureka HAWS, temporary closure refers to the shutting down operations for a period of time with the intention of resuming operations in the future. The period of shutdown could be for a week or longer and would be a function of political, economic, environmental, or social.To ensure that this component of the Site does not become a source of contamination or a safety hazard to wildlife and humans during temporary closure periods.

The political (sovereignty) and environmental (climate) roles played by Eureka HAWS make it unlikely that the Site will ever be abandoned. Notwithstanding, the basic abandonment and restoration objective would be to ensure that the various components of the Site do not become a source of contamination or a safety hazard to wildlife and humans during temporary closure periods. ECCC will ensure that the following general conditions are met:

- Sufficient staff are on-Site to protect the health and safety of humans, wildlife and the environment and the expertise is made available to care for the site and any potential problems that may arise;
- Sufficient equipment and supplies are left on Site for any maintenance or reclamation activities that may need to be implemented;
- Access to the Site, buildings and other structures will be secured and restricted to authorized personnel only;
- All legislated requirements (e.g., provisions of water licence) will be complied; and
- Warning signs continue to be posted, where appropriate.

| TEMPORARY CLOSURE PLAN - EUREKA | | |
|---|---|---|
| Site Component | Specific Abandonment and Restoration Objective | **Actions to be taken to achieve Objective** |
| • Operations & Barracks Buildings<br>• Maintenance garage<br>• Warehouses<br>• Shops & other buildings<br>• Pumphouse<br>• Electrical, plumbing & carpentry facilities<br>• Powerhouse<br>• Construction Worker Camp | • To ensure that this component of the Site does not become a source of contamination or a safety hazard to wildlife and humans during temporary closure periods. | • Implement the Standard Operating Procedures (SOP) for temporary closure of building<br>• See Appendix B for Building Temporary Closure SOP |
| • Water reservoir<br>• Water diversion area | • To ensure that this component of the Site does not become a source of contamination or a safety hazard to wildlife and humans during temporary closure periods. | • Implement the SOP for Temporary Closure of the water reservoir to ensure that water diversion area is closed before any temporary closure of the Site.<br>• See Appendix B for Lagoon and Earthen Manure Storage Structure Temporary Closure SOP |
| • Contaminated (oil, fuel, chemicals) sites | • To ensure that this component of the Site does not become a source of contamination or a safety hazard to wildlife and humans during temporary closure periods. | • Identify all open conduits in and around the contaminated sites<br>• Implement the SOP for contaminated sites and ensure that any open conduits (monitoring wells, open pits, etc.) are closed and secure.<br>• See Appendix B for Contaminated Sites Temporary Closure SOP |

| TEMPORARY CLOSURE PLAN - EUREKA | | |
|---|---|---|
| Site Component | Specific Abandonment and Restoration Objective | **Actions to be taken to achieve Objective** |
| • Infrastructure (e.g., airstrip, electrical power supply systems, culverts, barge landings, and associated infrastructure) | • To ensure that this component of the Site does not become a source of contamination or a safety hazard to wildlife and humans during temporary closure periods. | • Implement the SOP for temporary closure of infrastructure<br>• See Appendix B for Infrastructure Temporary Closure SOP |
| • Hazardous materials (e.g., POL Fluids, PCB containing material, ODS containing equipment, batteries, asbestos; compressed gas cylinders; lead-based paint) | • To ensure that this component of the Site does not become a source of contamination or a safety hazard to wildlife and humans during temporary closure periods. | • Determine temporary storage requirements of all hazardous materials<br>• Implement Temporary Storage Plan for hazardous materials<br>• See Appendix B Temporary Storage Plan for Hazardous Material |
| • Sewage Lagoon | • To ensure that this component of the Site does not become a source of contamination or a safety hazard to wildlife and humans during temporary closure periods. | • Identify all influent channels into Sewage Lagoon<br>• Implement Sewage Lagoon Temporary Closure SOP and ensure that all influent channels are closed during temporary closure periods<br>• See Appendix B for Lagoon and Earthen Manure Storage Structure Temporary Closure SOP |
| • Incinerator | • To ensure that this component of the Site does not become a source of contamination or a safety hazard to | • Determine temporary storage requirements for incinerator |

| TEMPORARY CLOSURE PLAN - EUREKA | | |
|---|---|---|
| Site Component | Specific Abandonment and Restoration Objective | **Actions to be taken to achieve Objective** |
| | wildlife and humans during temporary closure periods. | • Implement SOP for temporary shut-down and storage of incinerator<br>• See Appendix B for Incinerator Temporary Closure SOP |
| • Solid Waste Landfill Sites | • To ensure that this component of the Site does not become a source of contamination or a safety hazard to wildlife and humans during temporary closure periods. | • Identify all open conduits in and around the contaminated sites<br>• Implement the SOP for temporary closure of the solid waste landfill sites and to ensure that any open conduits (monitoring wells, open pits, etc.) are closed and secure<br>• See Appendix B for Solid Waste Landfill Site Temporary Closure SOP |
| • Barrels | • To ensure that this component of the Site does not become a source of contamination or a safety hazard to wildlife and humans during temporary closure periods. | • Apply general health and safety principles to ensure barrels do not pose a threat |
| • Blacktop Creek and West Remus Creek Quarry and Associated Temporary Infrastructure (e.g., mobile wash-car) | • To ensure that this component of the Site does not become a source of contamination or a safety hazard to wildlife and humans during temporary closure periods. | • Bulk fuel is removed from the quarry and placed back near storage area adjacent to camp near the airport<br>• Crusher equipment remains but is placed on high ground<br>• Surface re-grading was completed to ensure water is directed away from the |

| TEMPORARY CLOSURE PLAN - EUREKA | | |
|---|---|---|
| Site Component | Specific Abandonment and Restoration Objective | **Actions to be taken to achieve Objective** |
| | | crusher and any remaining stockpiles at the quarry<br>• Re-grading to promote positive flow through the quarry in anticipation of the next season's freshet flows<br>• General Site clean-up, garbage and hazmat removal to proper storage/disposal |
| • Hydrogen Generator | • To ensure that this component of the Site does not become a source of contamination or a safety hazard to wildlife and humans during temporary closure periods. | • If long term temporary closure and subzero temperatures are expected; remove electrolyte and purge the gasholder and storage tank as per sections 4.7.5, 5.3.16 and 5.3.17 of the Hydrogen Generator Technical Manual (Appendix C) |

## PERMANENT CLOSURE AND RECLAMATION

The following Permanent Closure and Reclamation Plan outlines specific abandonment and restoration objectives and actions to be taken to achieve those objectives for each of the facility components for permanent closure.

| PERMANANT CLOSURE PLAN - EUREKA | | |
|---|---|---|
| Site Component | Specific Abandonment and Restoration Objective | **Actions to be taken to achieve Objective** |
| • Operations & Barracks Buildings<br>• Maintenance garage<br>• Warehouses<br>• Shops & other buildings<br>• Pumphouse<br>• Electrical, plumbing & carpentry facilities<br>• Powerhouse<br>• Construction Worker Camp | • To ensure that this component of the Site does not become a source of contamination or a safety hazard to wildlife and humans during temporary closure periods.<br>• To return area to its original state | • Federal Heritage Building Review of following Site buildings:<br>o Older Operations Complex<br>o Old Garage<br>o Hydrogen Building<br>o Transient Barracks<br>o Bunkhouse<br>o Carpentry Shop<br>o Greenhouse<br>o Electrical Storage Building 9<br>o CWS Storage Building 19<br>o Eureka International (Strip Shack)<br>o Hydrogen Building<br>o Hose Reel Storage<br>• Conduct inventory of contents and building construction materials<br>• Consult with stakeholders to determine their storage requirements<br>• Decide which buildings can be declared surplus |

| PERMANANT CLOSURE PLAN - EUREKA | | |
|---|---|---|
| Site Component | Specific Abandonment and Restoration Objective | **Actions to be taken to achieve Objective** |
| | | • Retain the services of a qualified engineer to produce a Demolition Waste Disposal Plan<br>• Conduct an Environmental Assessment<br>• Obtain any necessary approvals [e.g., new landfill site(s)]<br>• Develop tender documents for the decommissioning of the buildings<br>• Determine successful candidate to implement Demolition Waste Disposal Plan<br>• Begin implementation of Demolition Waste Disposal Plan<br>• Conduct Site grading |
| • Water reservoir<br>• Water diversion area | • To ensure that this component of the Site does not become a source of contamination or a safety hazard to wildlife and humans during temporary closure periods.<br>• To return area to its original state | • Prepare decommissioning plan<br>• Conduct an Environmental Assessment<br>• Conduct Site grading |
| Contaminated (oil, fuel, chemicals) sites | • To ensure that this component of the Site does not become a source of contamination or a safety hazard to wildlife and humans during temporary closure periods. | • Site Assessment; listing and geographical extent of contamination based on EA Phase I and Geophysical Study; completed |

| PERMANANT CLOSURE PLAN - EUREKA | | |
|---|---|---|
| Site Component | Specific Abandonment and Restoration Objective | **Actions to be taken to achieve Objective** |
| | • To restore in such a fashion as to facilitate the natural use by wildlife | • Reconnaissance Testing Program; performed on all sites identified in EA Phase I Study to confirm nature and extent of contamination and any leachate issues;<br>• Risk-Based Analysis to determine which specific contaminated sites should be subjected to detailed and systematic testing;<br>• Detailed Testing Program on specific sites identified in the Risk-Based Analysis to accurately determine nature, extent, and rate of movement of contamination;<br>• Risk-Based Analysis to prioritize sites for remediation;<br>• Development of a Remediation Plan;<br>• Conduct and Environmental Assessment,<br>• Request for federal funding;<br>• Begin implementation of Remediation Plan;<br>• Post Remediation Monitoring (location and frequency based on recommendations flowing from |

| PERMANANT CLOSURE PLAN - EUREKA | | |
|---|---|---|
| Site Component | Specific Abandonment and Restoration Objective | **Actions to be taken to achieve Objective** |
| | | detailed testing program and risk-based analysis) |
| • Infrastructure (e.g., airstrip, electrical power supply systems, culverts, barge landings, and associated infrastructure) | • To ensure that this component of the Site does not become a source of contamination or a safety hazard to wildlife and humans during temporary closure periods.<br>• To recycle and reuse<br>• To restore natural drainage patterns where surface infrastructure has been removed<br>• To restore in such a fashion as to facilitate the natural use by wildlife | • Conduct inventory of materials<br>• Consult with stakeholders to determine their storage requirements<br>• Decide which infrastructure can be declared surplus<br>• Retain the services of a qualified engineer to produce a Demolition Waste Disposal Plan<br>• Conduct an Environmental Assessment<br>• Obtain any necessary approvals [e.g., new landfill site(s)]<br>• Develop tender documents for the decommissioning of the infrastructure<br>• Determine successful candidate to implement Demolition Waste Disposal Plan<br>• Begin implementation of Demolition Waste Disposal Plan<br>• Conduct Site grading |
| • Hazardous materials (e.g., POL Fluids, PCB containing material, ODS containing equipment, batteries, | • To ensure that this component of the Site does not become a source of contamination or a safety hazard to | • Conduct inventory of contents materials<br>• Consult with stakeholders to determine their storage requirements |

| PERMANANT CLOSURE PLAN - EUREKA | | |
|---|---|---|
| Site Component | Specific Abandonment and Restoration Objective | **Actions to be taken to achieve Objective** |
| asbestos; compressed gas cylinders; lead-based paint) | wildlife and humans during temporary closure periods.<br>• To recycle and reuse | • Decide which materials can be declared surplus<br>• Determine waste disposal approach<br>• Obtain any necessary approvals [e.g., new landfill site(s)]<br>• Develop tender documents for landfilling/hauling of hazardous waste<br>• Determine successful candidate to implement hazardous waste cleanup<br>• Begin implementation |
| • Sewage Lagoon | • To ensure that this component of the Site does not become a source of contamination or a safety hazard to wildlife and humans during temporary closure periods.<br>• To return area to its original state by grading it to match local topography and to facilitate re-vegetation where appropriate | • Conduct options analysis for sewage treatment & disposal at Site<br>• If, on the basis of the preceding preferred option, it is decided to:<br>o close the existing lagoon; or<br>o remove the existing sludge,<br>• the services of a qualified engineer will be obtained to determine whether the lagoon is/is not highly contaminated and to recommend a remediation option(s) which may include the following:<br>o the lagoon may be backfilled and shaped to blend in with existing |

| PERMANANT CLOSURE PLAN - EUREKA | | |
|---|---|---|
| Site Component | Specific Abandonment and Restoration Objective | **Actions to be taken to achieve Objective** |
| | | contours provided that measures are applied for leachate control;<br>o the sludge may be de-watered (eg. evaporation allowed to take place) and the dried residue removed and disposed of on-Site in an engineered land fill; or<br>o the de-watered sludge may be containerized, and land filled to preclude contact with the Arctic ecosystem.<br>• Award consultant contract to provide information for drafting the design build performance documents for new sewage treatment system (e.g., water/wastewater mass balance report)<br>• Draft and complete design build performance documents, including sludge treatment plan<br>• Develop tender documents for the Design-Build contract<br>• Close Design-Build contract<br>• Conduct Environmental Assessment |

| PERMANANT CLOSURE PLAN - EUREKA | | |
|---|---|---|
| Site Component | Specific Abandonment and Restoration Objective | **Actions to be taken to achieve Objective** |
| | | • Award Design-Build Contract<br>• Sewage Treatment System constructed at Site<br>• Remediate existing lagoon<br>• Post monitoring [location of monitoring sites and frequency of monitoring will be based on engineers recommendations (above)] |
| • Incinerator | • To ensure that this component of the Site does not become a source of contamination or a safety hazard to wildlife and humans during temporary closure periods.<br>• To recycle and reuse | • Removed from the site and re-used |
| • Solid Waste Landfill Sites | • To ensure that this component of the Site does not become a source of contamination or a safety hazard to wildlife and humans during temporary closure periods.<br>• To return area to its original state | • Site Assessment; listing and geographical extent of contamination based on EA Phase I and Geophysical Study; completed<br>• Reconnaissance Testing Program; performed on all sites identified in EA Phase I Study to confirm nature and extent of contamination and any leachate issues; |

| PERMANANT CLOSURE PLAN - EUREKA | | |
|---|---|---|
| Site Component | Specific Abandonment and Restoration Objective | **Actions to be taken to achieve Objective** |
| | | • Risk-Based Analysis to determine which specific contaminated sites should be subjected to detailed and systematic testing;<br>• Detailed Testing Program on specific sites identified in the Risk-Based Analysis to accurately determine nature, extent, and rate of movement of contamination;<br>• Risk-Based Analysis to prioritize sites for remediation;<br>• Development of a Holistic Remedial Action Plan (RAP);<br>• Request for federal funding;<br>• Implement RAP (free product first, purchase and mobilize any needed equipment – 2 year plan);<br>• Implement RAP (free product, mobilize any other equipment, begin construction);<br>• Remediation during summer seasons<br>• Post Remediation Monitoring (location and frequency based on recommendations flowing from detailed testing program and risk-based analysis) |

| PERMANANT CLOSURE PLAN - EUREKA | | |
|---|---|---|
| Site Component | Specific Abandonment and Restoration Objective | **Actions to be taken to achieve Objective** |
| • Barrels | • To ensure that this component of the Site does not become a source of contamination or a safety hazard to wildlife and humans during temporary closure periods. | • Empty barrels will be crushed and disposed in an on-Site engineered landfill or disposed of off-Site<br>• filled or partially filled barrels will be inspected and tested if necessary and disposed of appropriately (off-Site or incineration). The empty barrels will be rinsed, crushed, and disposed on-Site in an engineered landfill. The spent rinse liquid will be treated with absorbent material and disposed as hazardous material<br>• Buried empty barrels will be inspected to determine if any of the barrels contain material. If the barrels are found to be empty, the area will be stabilized through compaction to crush any corroded barrels. A cover of borrow material will be placed over the area and compacted |
| • Blacktop Creek and West Remus Creek Quarry and Associated Temporary Infrastructure (e.g., mobile wash-car) | • To ensure that this component of the Site does not become a source of contamination or a safety hazard to wildlife and humans during temporary closure periods.<br>• To return area to original state | • If quarry floor soil is contaminated, soil will be placed into drums for disposal off-Site.<br>• Grading of pit floor to promote drainage using baselines and survey elevations |

| PERMANANT CLOSURE PLAN - EUREKA | | |
|---|---|---|
| Site Component | Specific Abandonment and Restoration Objective | **Actions to be taken to achieve Objective** |
| | | • Trimming of slopes<br>• Remove of any temporary Infrastructure from site (e.g., mobile wash-car) |
| • Hydrogen Generator | • To ensure that this component of the Site does not become a source of contamination or a safety hazard to wildlife and humans during temporary closure periods.<br>• To recycle and reuse | • Removal of electrolyte and purging of gasholder and storage tanks<br>• Removed from Site and reused |

## MONITORING OF ON-GOING RESTORATION ACTIVITIES

A monitoring program will be carried out to record the progress of progressive restoration activities. Monitoring activities may include visual inspection to determine if:

- Water is ponding on the landfill cover;
- The landfill cover is eroding;
- Frost action is occurring; and
- The permafrost is developing within the landfill consistent with the design.

Monitoring of the contaminated sites will follow a pre-established program and will occur at regular intervals following closure of the Site. Contaminated areas that have been excavated will be confirmed clean by field screening methods and samples taken for laboratory confirmation. Once it has been demonstrated that the Site is physically and chemically stable, the frequency of monitoring will be reduced. Physical stability will be established as a minimum through visual inspection and may include instrumentation for thermal monitoring. Chemical stability will be confirmed through the collection of suitable samples from around the site.

The details of the pre-established monitoring program (the location of monitoring stations and frequency and duration of monitoring) will be a function of the recommendations of the engineer and will be outlined in subsequent revisions to this document following Detailed Testing Program and the Risk-Based Analyses of the sites (e.g., proximity to sensitive receptors) in question.

## FINAL LANDSCAPE: SITE GRADING & AESTHETICS

Disturbed areas will be graded and shaped to blend in with the natural contours and to eliminate potential hazards for wildlife, humans accessing the site in the future.

To facilitate physical stability, improve the aesthetics of sites subjected to progressive restoration, ECCC will begin re-vegetation efforts, where appropriate, immediately following such restoration. Consideration will be given to:

- Seeding areas with native seed mixes;
- Applying stockpiled soil or growth medium to a depth sufficient to maintain root growth and nutrient requirements;
- Incorporation of organic materials based upon local soil assessment;
- Establishing temporary or permanent windbreaks;
- Transplanting vegetation will be lost to progressive restoration activities; and
- Placing gravel on sites to discourage vegetation growth where desired.

## TREATMENT OF UNACCEPTABLE DISCHARGE FOLLOWING PROGRESSIVE RESTORATION/CLOSURE

In the event that drainage water from any reclaimed facility is not acceptable for discharge, ECCC would retain the services of a qualified engineer to recommend measures, based on a risk-based analysis, to ensure that human and environmental safety were not jeopardized.

# REFERENCES


AECOM Canada Ltd (AECOM), 2021:
Hazardous and Non-Hazardous Waste Survey Eureka High Arctic Weather Station, Eureka NU

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Contaminated Sites Remediation Framework

Franz Environmental Inc., 2010:
Phase III Environmental Site Assessment Eureka High Arctic Weather Station, Nunavut, Canada.

Indian and Northern Affairs Canada, March 2005:
Abandoned Military Site Remediation Protocol.

Indian and Northern Affairs Canada, Yellowknife, NWT, January 2006:
Mine Site Reclamation Guidelines for the Northwest Territories.

Public Works and Government Services Canada, Nunavut February 2007:
Phase I Environmental Site Assessment Eureka High Arctic Weather Station, Eureka,

# APPENDIX A: Current Licenses and Permits

# CONDITIONS ANNEXED TO AND FORMING PART OF LAND USE PERMIT NUMBER N2017N0017

Amended June 18, 2018

**Failure to comply with any term and condition issued as part of this permit is an offence under the Territorial Lands Act. Every person who commits an offence is liable, on summary conviction, for a first offence, to a fine not exceeding $100 000, and for a second or subsequent offence, to a fine not exceeding $200 000. Please note that an offence that is committed on more than one day constitutes a separate offence for each day on which it is committed or continued.**

## 31 (1) (a) – Location and Area

| | | |
|---|---|---|
| 1. | The Permittee shall not conduct this land use operation on any land(s) not designated in the accepted application, unless otherwise authorized in writing by the Engineer. | AUTHORIZED AREA OF ACTIVITY |
| 2. | a) The Permittee shall offset vehicle travel in areas without a snow covered surface.<br><br>b) The Permittee shall confine the line to a maximum width of 10 metres unless otherwise authorized in writing by a Land Use Inspector. | OFFSET VEHICLE TRAVEL |
| 3. | The Permittee shall locate all camps on gravel, sand or other durable land. | CAMP LOCATION |
| 4. | The Permittee shall use existing campsite. | CAMP LOCATION |
| 5. | The Permittee shall locate all lines, trails and rights-of-way to be constructed parallel to streams a minimum of thirty one (31) meters from any stream except at crossings unless otherwise authorized in writing by a Land Use Inspector. | PARALLELLING STREAMS |
| 6. | The Permittee shall not erect camps or store/stage material on the surface of frozen streams or lakes including the immediate banks except what is for immediate use. | STORAGE ON ICE |

## 31 (1) (b) – Time

| | | |
|---|---|---|
| 7. | The Permittee's Field Supervisor shall contact or meet with a Land Use Inspector at the Department of Indigenous and Northern Affairs Canada, phone number (867) 975-4517; at least 48 hours prior to the commencement of this land use operation. | CONTACT INSPECTOR |
| 8. | The Permittee shall advise a Land Use Inspector at least 10 days prior to the completion of the land use operation of:<br><br>a) a plan for removal or storage of equipment and materials, and;<br><br>b) when final clean-up and restoration of the lands used will be completed. | REPORTS BEFORE REMOVAL |
| 9. | The Permittee's Field Supervisor shall provide notification of commencement of the land use operation within 10 days, to the Engineer at the Iqaluit office of the Department of Indigenous and Northern Affairs Canada either by emailing landsmining@aandc.gc.ca or by telephone at (867) 975-4283. | NOTICE TO ENGINEER |

| | | |
|---|---|---|
| 10. | The Permittee shall provide updated locations of the following activities, if applicable, related to this project to the Inspector and Engineer within 10 days of establishment :<br><br>a) Campsite<br>b) Fuel caches<br>c) Airstrip<br>d) Drill laydown area<br>e) Quarry locations<br><br>All coordinates must be provided in degree/min/sec format in NAD 83. | UPDATE LOCATIONS |
| 11. | The Permittee shall provide in writing to the Engineer, at least forty-eight (48) hours prior to commencement of this land use operation, the following information:<br><br>a) person, or persons, in charge of the field operation to whom notices, orders, and reports may be served,<br><br>b) alternates, and;<br><br>c) all the indirect methods for contacting the above person(s). | IDENTIFY AGENT |
| 12. | The Permittee shall submit an annual report to the Engineer by March 30 of each year of permitted activities. The annual report must contain, but not limited to, the following information:<br><br>a) a technical summary of the activities undertaken for the year,<br><br>b) a table and map showing the following items, if applicable, with exact coordinates in degree/min/sec format, in NAD 83:<br><br>i. All drilling locations<br>ii. All fuel caches<br>iii. Any other locations where activities were conducted<br><br>c) a work plan for the following year,<br><br>d) any progressive reclamation work undertaken. | ANNUAL REPORTING |
| 13. | The Permittee shall complete all clean-up and restoration of the lands used prior to the expiry date of this permit. | CLEAN-UP |
| 14. | The Engineer reserves the right to impose closure to any area to the Permittee in periods when dangers to natural resources are severe. | CLOSURE |

**31 (1) (c) – Equipment**

| | | |
|---|---|---|
| 15. | The Permittee shall not use any equipment except of the type, size and number that is listed in the accepted application, unless otherwise authorized in writing by the Land Use Inspector. | ONLY APPROVED EQUIPMENT |

| | | |
|---|---|---|
| 16. | The Permittee shall use a forced-air fuel-fired incinerator to incinerate all combustible garbage and debris. If no incinerator is being established on site, garbage must be backhauled to an approved disposal facility. | INCINERATORS |
| 17. | The Permittee shall keep all garbage and debris in a covered container until disposed of at an approved facility. Garbage must be stored in such a manner as to prevent access by wildlife. | GARBAGE CONTAINERS |
| 18. | The Permittee shall ensure that appropriate spill response equipment and clean-up materials (e.g. shovels, pumps, barrels, drip pans, and absorbents) must be readily available during any transfer of fuel or hazardous substances, as well as at fuel caches and drill sites. All activities should be conducted according to the approved Spill Response Plan. | SPILL RESPONSE KIT |

**31 (1) (d) - Methods and Techniques**

| | | |
|---|---|---|
| 19. | The Permittee shall ensure that there is no blasting of any kind under this quarry permit. | NO BLASTING |

**31 (1) (e) - Type, Location, Capacity and Operation of Facilities**

| | | |
|---|---|---|
| 20. | The Permittee shall not locate any sump within thirty one (31) metres of the normal high water mark of any water body. Sumps and areas designated for waste disposal shall be sufficiently bermed or otherwise contained to ensure that substances do not enter a waterway unless otherwise authorized. | SUMPS FROM WATER |
| 21. | The Permittee shall backfill and restore all sumps prior to the expiry date of this permit or immediately following completion of activity. | BACKFILL SUMPS |
| 22. | The Permittee shall:<br>a) backfill sumps with sufficient material to ensure that no hollows or cavities result from settling of the material;<br>b) Overlap the replaced material a minimum of one (1) metre beyond the edges of the existing sump wall. | BACKFILL SUMP OVERLAP |
| 23. | The Permittee shall ensure that the land use area is kept clean and tidy at all times. | CLEAN WORK AREA |
| 24. | The Permittee shall clearly stake and flag pit and quarry boundaries so they remain visible to other land users throughout the year and do not present a hazard to overland travel. | QUARRY IDENTIFICATION |
| 25. | The Permittee shall not conduct any quarrying activity within thirty-one (31) meters of the high water mark of any water body. | LOCATION OF QUARRY ACTIVITY |
| 26. | The Permittee shall locate any screening and crushing equipment to be utilized on stable ground, at a location with ready access to stockpiles. | LOCATION OF QUARRYING EQUIPMENT |

| | | |
|---|---|---|
| 27. | The Permittee shall only treat petroleum and hydrocarbon contaminated soils at the landfarm facility. Materials contaminated with other substances must not be stored at the land farm and must be disposed of at an authorized facility. | LANDFARM OPERATIONS |
| 28. | The Permittee shall ensure that all equipment used for aeration in the landfarm operation has been cleaned off within the landfarm facilities prior to exiting. | LANDFARM EQUIPMENT |

**31 (1) (f) - Control or Prevention of Flooding, Erosion and Subsidence of Land**

| | | |
|---|---|---|
| 29. | The Permittee shall remove any obstruction to natural drainage caused by any part of this land use operation. | NATURAL DRAINAGE |
| 30. | The Permittee shall not use the bed of streams for access routes except for the purpose of crossing the streams unless otherwise authorized by a Land Use Inspector. | STREAM BEDS ACCESS |
| 31. | The Permittee shall install erosion and sediment mitigation measures on disturbed areas before, during and after construction and as the land use operation progresses. | EROSION CONTROL |
| 32. | The Permittee shall prepare the site in such a manner as to prevent rutting of the ground surface. | PREVENTION OF RUTTING |
| 33. | The Permittee shall not move any equipment or vehicles unless the ground surface is in a state capable of fully supporting the equipment or vehicles without rutting or gouging. | VEHICLE MOVEMENT FREEZE-UP |
| 34. | The Permittee shall suspend overland travel of equipment or vehicles if rutting occurs. | SUSPEND OVERLAND TRAVEL |

**31 (1) (g) - Use, Storage, Handling and Disposal of Chemical or Toxic Material**

| | | |
|---|---|---|
| 35. | The Permittee shall remove all garbage and debris from the area of the land use operation to a disposal site approved in writing by a Land Use Inspector. | REMOVE GARBAGE |
| 36. | The Permittee shall deposit all sewage into a sump. | SEWAGE DISPOSAL |
| 37. | The Permittee shall store all fuel and chemicals in such a manner as to prevent access by wildlife | STORAGE |
| 38. | The Permittee shall incinerate all combustible wastes daily and remove ash from incineration activities. | GARBAGE DISPOSAL |
| 39. | The Permittee shall backhaul and dispose all combustible waste petroleum products at an approved disposal facility unless there is an approved waste oil burner on site. | WASTE PETROLEUM DISPOSAL |

| | | |
|---|---|---|
| 40. | The Permittee shall backhaul and dispose of all hazardous wastes at an approved waste disposal facility. | WASTE CHEMICAL DISPOSAL |
| 41. | The Permittee shall report all spills immediately in accordance with instructions contained in "NT-NU Spill Report" form and to the twenty four (24) hour spill report line (867)920-8130. | REPORT CHEMICAL AND PETROLEUM SPILLS |
| 42. | The Permittee shall not allow petroleum products or chemicals to spread to surrounding lands or into water bodies. | CONTAINMENT OF PETROLEUM PRODUCTS AND CHEMICALS |

**31 (1) (h) - Wildlife and Fisheries Habitat**

| | | |
|---|---|---|
| 43. | The Permittee shall not unnecessarily damage wildlife habitat in conducting this land use operation. | HABITAT DAMAGE |
| 44. | The Permittee shall not obstruct the movement of fish while conducting this land use operation. | FREE FISH MOVEMENT |
| 45. | The Permittee shall not harass wildlife. This includes persistently worrying, chasing, or disturbing large groups of animals. | HARASSMENT OF WILDLIFE |
| 46. | The Permittee shall not disturb or destroy the nests or eggs of any birds. If nests are encountered and/or identified, the Permittee shall take precaution to avoid further interaction and/or disturbance (e.g. a 100 meter buffer around the nests). If active nests are discovered (i.e. with eggs or young) the Permittee shall avoid these areas until nesting is complete and the young have left the nest. | WILDLIFE SENSITIVITY |
| 47. | The Permittee shall not touch, feed or entice wildlife to approach by holding out of setting out decoys or any such devise, foodstuffs or bait of any kind. | WILDLIFE INTERACTIONS |

**31 (1) (k) - Petroleum Fuel Storage**

| | | |
|---|---|---|
| 48. | The Permittee shall not place any petroleum fuel storage containers within thirty-one (31) metres of the normal high water mark of any water body. | FUEL STORAGE |
| 49. | The Permittee shall locate mobile fuel facilities on land when stationary for any period of time exceeding twelve (12) hours. | FUEL ON LAND |
| 50. | The Permittee shall not allow petroleum products to spread to surrounding lands or into water bodies. | FUEL CONTAINMENT |
| 51. | The Permittee shall:<br>a) examine all fuel storage containers for leaks a minimum of once every seven (7) days during operations;<br>b) repair all leaks immediately;<br>c) examine all fuel storage containers for leaks immediately upon delivery. | CHECK FOR LEAKS |

| | | |
|---|---|---|
| 52. | The Permittee shall construct a dyke around each stationary fuel container where any one container, or group of fuel containers piped together, has a capacity exceeding 50,000 litres. | DYKE FUEL CONTAINERS |
| 53. | The Permittee shall line the dyke and area enclosed by the dyke with a type of plastic film liner approved by the Engineer. | LINE DYKE |
| 54. | The Permittee shall ensure that the dyke and the area enclosed by the dyke shall be impermeable to petroleum products at all times. | IMPERMEABLE DYKE |
| 55. | The Permittee shall seal all container outlets except the outlet currently in use. | SEAL OUTLET |
| 56. | The Permittee shall mark all fuel containers with the Permittee's name and the Land Use Permit number. | MARK CONTAINERS |
| 57. | The Permittee shall use adequate secondary containment or a surface liner (e.g. self-supporting insta-berms and fold-a-tanks), when storing barrelled fuel and chemicals at all locations as well as re-fuelling stations. The volume of the berm area shall be 10% greater than the capacity of the largest fuel container placed therein. | SECONDARY CONTAINMENT |
| 58. | The Permittee shall remove and treat hydrocarbon contaminated soils on site or transport them to an approved disposal site for treatment. | CONTAMINATED SOIL |

**31 (1) (m) - Matters Not Inconsistent with the Regulations**

| | | |
|---|---|---|
| 59. | The Permittee shall display a copy of this permit in a conspicuous place in each campsite established to carry out this land use operation. | DISPLAY PERMIT |
| 60. | The Permittee shall keep on hand, at all times during this land use operation, a copy of the Land Use Permit. | COPY OF PERMIT |
| 61. | The Permittee shall conspicuously display the land use permit number on all vehicles and equipment. | DISPLAY PERMIT NUMBER |
| 62. | The Permittee shall abide by and comply with all applicable lawful rules, acts, regulations, and by-laws of Canada, Nunavut, any Municipal or regulatory body or authority having jurisdiction, the Nunavut Land Claim Agreement, and all other agreements, permits, licenses, and other instruments whatsoever related to the project. | ADHERENCE TO LAWFUL RULES, ACTS, REGS & BYLAWS |

## ARCHAELOGICAL & PALEONTOLOGICAL TERMS AND CONDITIONS

| | | |
|---|---|---|
| | "archaeological site" means a place where an archaeological artifact is found.<br><br>"archaeological artifact" means any tangible evidence of human activity that is more than 50 years old and in respect of which an unbroken chain of possession or regular pattern of usage cannot be demonstrated, and includes a Denesuline archaeological specimen referred to in section 40.4.9 of the Nunavut Land Claims Agreement.<br><br>"paleontological site" means a site where a fossil is found.<br><br>"fossil" includes:<br><br>(a) natural casts<br><br>(b) Preserved tracks, coprolites and plant remains; and<br><br>(c) the preserved shells and exoskeletons of invertebrates and the eggs, teeth and bones of vertebrates. | DEFINITIONS |
| | The Permittee shall avoid any known or suspected archaeological and/or paleontological sites. | AVOIDANCE OF ARCHAELOGICAL AND/OR PALEONTOLOGICAL SITES |
| | The Permittee shall not remove, disturb, or displace any archaeological artifact or site, or any paleontological site or fossil. | DISTURBANCE OF ARCHAELOGICAL AND/OR PALEONTOLOGICAL SITE |
| | The Permittee shall immediately cease any activity should a suspected archaeological, paleontological, or burial site be discovered during the course of a land use operation.<br><br>The Permittee is required to immediately contact the Land Administration division at Indigenous and Northern Affairs Canada at (867) 975-4283 or (867) 975-4285 or (867) 975-4280 as well as the Department of Culture and Heritage at (867) 934-2046 or (867) 975-5500 or 1 (866) 934-2035. | CEASE OPERATION OF LAND USE ACTIVTY |

| | | |
|---|---|---|
| | Permission to resume land use operation must be obtained from the engineer. At such time the Engineer may, at his/her discretion, require that you have an archaeologist or palaeontologist perform the following functions:<br><br>(a) Survey<br><br>(b) Inventory and documentation of the archaeological or<br><br>(c) Paleontological resources of the land use area<br><br>(d) Assessment of potential for damage to archaeological or paleontological sites<br><br>(e) Mitigation<br><br>(f) Marking boundaries of archaeological or paleontological sites<br><br>(g) Site restoration | |
| | The Permittee shall ensure that all persons working under the authority of the permit are aware of these conditions pertaining to archaeological sites and artifacts as well as paleontological sites and fossils. | KNOWLEDGE OF ARCHAELOGICAL AND PALEONTOLOGICAL TERMS AND CONDITIONS |

**Species at Risk in Nunavut**

This list includes species listed on one of the Schedules of SARA (Species at Risk Act) and under consideration for listing on Schedule 1 of SARA. These species have been designated as at risk by COSEWIC (Committee on the Status of Endangered Wildlife in Canada). This list may not include all species identified as at risk by the Territorial Government.

a) Schedule 1 is the official legal list of Species at Risk for SARA. SARA applies to all species on Schedule 1. The term "listed" species refers to species on Schedule 1.

(b) Schedule 2 and 3 of SARA identify species that were designated at risk by the COSEWIC prior to October 1999 and must be reassessed using revised criteria before they can be considered for addition to Schedule 1.

(c) Some species identified at risk by COSEWIC are "pending" addition to Schedule 1 of SARA. These species are under consideration for addition to Schedule 1, subject to further consultation or assessment.

Schedules of SARA are amended on a regular basis so it is important to periodically check the SARA registry (www.sararegistry.gc.ca) to get the current status of a species.

| Terrestrial Species at Risk | COSEWIC Designation | Schedule of SARA | Government with Lead Management Responsibility |
|---|---|---|---|
| Eskimo Curlew | Endangered | Schedule 1 | EC |
| Ivory Gull | Endangered | Schedule 1 | EC |
| Ross' Gull | Threatened | Schedule 1 | EC |
| Harlequin Duck (Eastern Population) | Special Concern | Schedule 1 | EC |
| Rusty Blackbird | Special Concern | Schedule 1 | Government of Nunavut |
| Felt-leaf Willow | Special Concern | Schedule 1 | Government of Nunavut |
| Peregrine Falcon | Special Concern (*anatun-tundrius* complex) | Schedule 1 (*anatum*) Schedule 3 (*tundrius*) | Government of Nunavut |
| Short-eared Owl | Special Concern | Schedule 3 | Government of Nunavut |
| Peary Caribou | Endangered | Schedule 1 | Government of Nunavut |
| Barren-ground Caribou (Dolphin and Union population | Special Concern | Schedule 1 | Government of Nunavut |
| Polar Bear | Special Concern | Schedule 1 | Government of Nunavut |
| Red Knott (*rufa* subspecies) | Endangered | Pending | EC |
| Red Knot (*islandica* subspecies) | Special Concern | Pending | EC |
| Porsild's Bryum | Threatened | Pending | GN |
| Horned Grebe (Western population | Special Concern | Pending | EC |
| Grizzly Bear | Special Concern | Pending | Government of Nunavut |
| Wolverine (Western Population) | Special Concern | Pending | Government of Nunavut |
| Atlantic Cod. Arctic Lakes | Special Concern | No Schedule | DFO |
| Atlantic Walrus | Special Concern | Pending | DFO |
| Beluga Whale (Cumberland Sound population) | Threatened | Pending | DFO |
| Beluga Whale (Hudson Bay population) | Endangered | Pending | DFO |
| Beluga Whale (Western Hudson Bay population) | Special Concern | Pending | DFO |
| Beluga Whale (Eastern High Arctic – Baffin Bay population) | Special Concern | Pending | DFO |
| Bowhead Whale (Eastern Canada – West Greenland population) | Special Concern | Pending | DFO |
| Killer Whale (Northwest Atlantic / Eastern Arctic populations) | Special Concern | Pending | DFO |
| Narwhal | Special Concern | Pending | DFO |

# TERRITORIAL QUARRYING REGULATIONS

## QUARRYING PERMIT NO. 2018QP0001

Permit issued under Section 12(1) of Territorial Quarrying Regulations.

Environment & Climate Change Canada

of PO Box 33, Cambridge Bay, NU, is hereby authorized to take 75,000 cubic meters of gravel from the lands described as follows: From one (1) Borrow area Ramus Creek, Eureka, Baffin, NU, NTS 49G.

SUBJECT TO THE FOLLOWING CONDITIONS:

1. This permit expires thirty-six months from the date of issue or when the authorized quantity of material has been quarried or removed, whichever is the sooner.
2. This permit does not grant to the Permittee any exclusive right or leasehold interest in the land described herein.
3. This permit shall not be assigned.
4. All quarrying under this permit shall be carried out in accordance with the Nunavut Mining Safety Ordinance.
5. This permit is subject to the provisions of the Territorial Quarrying Regulations and the conditions set out herein. Failure to comply with the provisions of the Regulations and the conditions prescribed in this permit may result in cancellation of the permit in accordance with Section 12(5) of the Territorial Quarrying Regulations without prior notice to the Permittee.
6. The Permittee will identify the work area to the satisfaction of the Land Use Inspector prior to the removal of any material and any change in location will require prior approval of the Land Use Inspector.
7. The Permittee will not work any area worked by any other Permittee except as co-ordinated by the Land Use Inspector.
8. No material is to be removed from any land protected by a registered mineral claim, without the Permittee obtaining prior permission of the registered owner(s).
9. Prior to the tenth day of each month, the Permittee shall submit a report to the Land Use Inspector at Iqaluit, Nunavut, indicating the quantity of material quarried and the quantity of material removed from the site.
10. Upon expiration of this Permit, as prescribed in Condition One, the Permittee shall level the excavation and restore the lands to the satisfaction of the Land Use Inspector within 30 days of said expiration date or as may be authorized by the Land Use Inspector.
11. Land Use Permit LUP # N2017N0017 and its operating conditions will apply.

Issued at Iqaluit, this 18th day of June, 2018.

Land Agent

Coe, Leslie

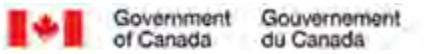
From: Cloutier-Dussault, Jean-Philippe (EC)
Sent: Thursday, August 30, 2018 9:22 AM
To: Pugh, Leeann (AADNC/AANDC)
Cc: Churchill, Laura (AADNC/AANDC)
Subject: RE: Quarry Permit

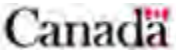
Thank you very much Ladies.

Jean-Philippe Cloutier-Dussault

Gestionnaire immobilier, Directions des actifs, des biens immobiliers et de la sécurité
Environnement et Changement climatique Canada / Gouvernement du Canada
jean-philippe.cloutier-dussault@canada.ca / Tél. : 514-283-4045

Property Manager, Assets, Real Property and Security Directorate
Environment and Climate Change Canada / Government of Canada
jean-philippe.cloutier-dussault@canada.ca / Tel. : 514-283-4045




De : Pugh, Leeann (AADNC/AANDC)
Envoyé : 30 août 2018 11:21
À : Cloutier-Dussault, Jean-Philippe (EC)
Cc : Churchill, Laura (AADNC/AANDC)
Objet : RE: Quarry Permit

Good morning Jean-Philippe,

This email is to confirm that our office has amended your quarry amounts for 2018QP0001 from 75, 000 to 250,000 cubic metres under Land Use Permit N2017N0017. Please note, all terms and conditions still apply.

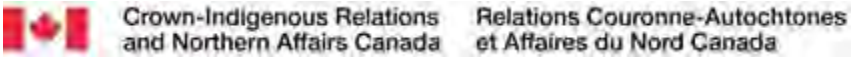
In regards to reporting, our office will require the amounts extracted from the pit but left in the quarry.

Should you have any questions, please let me know.

Regards,

Lee Ann

**Lee Ann Pugh**
**Land Administrator Specialist**
**Crown-Indigenous Relations and Northern Affairs Canada**
**Leeann.Pugh@Canada.ca / Tel: 867-975-4283**



From: Cloutier-Dussault, Jean-Philippe (EC)
Sent: Tuesday, August 28, 2018 3:11 PM
To: Qamaniq-Mason, Isa (AADNC/AANDC)
Cc: Laura MacKay (Laura.MacKay@pwgsc-tpsgc.gc.ca); Paul Ducharme (Paul.Ducharme@pwgsc-tpsgc.gc.ca); Pugh, Leeann (AADNC/AANDC)
Subject: RE: Quarry Permit
Importance: High

Good day Isa,

It seems that I made a mistake on the application for quarry permit #2018QP0001. The total quantity of aggregates requested was supposed to be 250,000 cubic meters over a period of 36 months. I requested only 75,000.

Please contact me regarding this issue. I can do a permit amendment application.

Also, I would like to inquire if we they need to report on aggregate amounts that are extracted but left in the quarry ?

Kind regards,

Jean-Philippe Cloutier-Dussault

Gestionnaire immobilier, Directions des actifs, des biens immobiliers et de la sécurité
Environnement et Changement climatique Canada / Gouvernement du Canada
jean-philippe.cloutier-dussault@canada.ca / Tél. : 514-283-4045

Property Manager, Assets, Real Property and Security Directorate
Environment and Climate Change Canada / Government of Canada
jean-philippe.cloutier-dussault@canada.ca / Tel. : 514-283-4045

Government of Canada Gouvernement du Canada

Canada

De : Qamaniq-Mason, Isa (AADNC/AANDC)
Envoyé : 11 juillet 2018 14:37
À : Cloutier-Dussault, Jean-Philippe (EC)
Objet : Quarry Permit

Good afternoon Jean-Philippe,

I noticed that I had entered the wrong address for ECCC's Quarry Permit 2018QP0001. Here is a scanned copy of the Permit with the correct address, I also sent out a hard copy through the mail.

Isa Qamaniq-Mason
Land Administrator
Land Administration
Indigenous and Northern Development Canada
Tel: (867) 975-4566
Email: Isa.Qamaniq-Mason@Canada.ca

# TERRITORIAL QUARRYING REGULATIONS

## QUARRYING PERMIT NO. 2020QP0002

Permit issued under Section 12(1) of Territorial Quarrying Regulations.

Environment & Climate Change Canada

of 160 Chemin Tour de L'Isle, Montreal, QC H3C 4G8, is hereby authorized to take 950 cubic meters of sand from the lands described as follows: From one (1) Borrow area West of Eureka HAWS, Baffin, NU, NTS 49G.

SUBJECT TO THE FOLLOWING CONDITIONS:

1. This permit expires thirty-six months from the date of issue or when the authorized quantity of material has been quarried or removed, whichever is the sooner.
2. This permit does not grant to the Permittee any exclusive right or leasehold interest in the land described herein.
3. This permit shall not be assigned.
4. All quarrying under this permit shall be carried out in accordance with the Nunavut Mining Safety Ordinance.
5. This permit is subject to the provisions of the Territorial Quarrying Regulations and the conditions set out herein. Failure to comply with the provisions of the Regulations and the conditions prescribed in this permit may result in cancellation of the permit in accordance with Section 12(5) of the Territorial Quarrying Regulations without prior notice to the Permittee.
6. The Permittee will identify the work area to the satisfaction of the Land Use Inspector prior to the removal of any material and any change in location will require prior approval of the Land Use Inspector.
7. The Permittee will not work any area worked by any other Permittee except as co-ordinated by the Land Use Inspector.
8. No material is to be removed from any land protected by a registered mineral claim, without the Permittee obtaining prior permission of the registered owner(s).
9. Prior to the tenth day of each month, the Permittee shall submit a report to the Land Use Inspector at Iqaluit, Nunavut, indicating the quantity of material quarried and the quantity of material removed from the site.
10. Upon expiration of this Permit, as prescribed in Condition One, the Permittee shall level the excavation and restore the lands to the satisfaction of the Land Use Inspector within 30 days of said expiration date or as may be authorized by the Land Use Inspector.
11. Land Use Permit LUP # N2017N002 and its operating conditions will apply.

Issued at Iqaluit, this 27th day of February, 2020.

Land Agent



Canada

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NUNAVUT WATER BOARD
NUNAVUT IMALIRIYIN KATIMAYINGI
OFFICE DES EAUX DU NUNAVUT

**8BC-EUR1621 / Amendment No.1**

July 18, 2018

Mr. Jean Philippe Cloutier
Property Management Division
Environment Canada (ECCC)
335 River Road
Ottawa, ON, K1V 1C7

Email: jean-philippe.cloutier-dussault@canada.ca
marc.stemarie@canada.ca

**RE: 8BC-EUR1621 Type 'B' Water Licence – Amendment No.1**

Dear Mr. Cloutier:

Please find attached, Amendment No.1 to Type "B" Water Licence 8BC-EUR1621 (Licence), issued to Environment and Climate Change Canada (ECCC), by the Nunavut Water Board (NWB) (**Motion 2018-B1-019**) pursuant to its authority under Article 13 of the *Agreement between the Inuit of the Nunavut Settlement Area and Her Majesty the Queen in Right of Canada (Nunavut Agreement)* and the *Nunavut Waters and Nunavut Surface Rights Tribunal Act (NWNSRTA)*. The terms and conditions of the original Licence and subsequent amendments related to water use and waste disposal remain an integral part of this approval.

The NWB strongly recommends that the Licensee consult the comments received by interested persons on issues identified[1]. This information is attached for your consideration.

Sincerely,

Lootie Toomasie
Nunavut Water Board
Chair

LT/dd/rqd

Enclosure: Licence No. **8BC-EUR1621 - Amendment No.1**
Comments – DFO, CIRNAC
Cc: Qikiqtani Distribution List

**DECISION**

**LICENCE 8BC-EUR1621 AMENDMENT No.1**

| | |
|---|---|
| **Licensee:** | **Environment and Climate Change Canada.** |
| **Licence No:** | **8BC-EUR1621 Type "B"** |
| **Licence Issued:** | **August 11, 2016** |
| **Amendment Effective:** | **July 18, 2018** |
| **Licence Expiry:** | **August 10, 2021** |

Pursuant to its authority under Article 13 of the *Agreement between the Inuit of the Nunavut Settlement Area and Her Majesty the Queen in Right of Canada* and the *Nunavut Waters and Nunavut Surface Rights Tribunal Act,* with respect to the application for amendment submitted on June 14, 2018, by Environment and Climate Change Canada, for the Eureka High Arctic Weather Station (HAWS) Project, the Nunavut Water Board hereby grants the following Licence amendment.

Licence 8BC-EUR1621, with respect to use of water and deposit of waste, shall be amended with terms and conditions, allowing ECCC, to undertake the following in support of the HAWS Project:

- Upgrade an existing all-terrain vehicle (ATV) path/trail to a six (6) metre wide permanent road from West Remus Creek to the current Eureka runway for a total length of approximately 12 kilometres (km);
- Development of a new borrow area located at West Remus Creek for use of up to 75,000 cubic metres ($m^3$) aggregate to construct road;
- Placement of culverts along to road to drain melt runoff including two (2) Arch culverts in Blacktop Creek to create a culvert bridge;
- Movement of crusher from Blacktop Creek to West Remus Creek;
- Use of water from West Remus Creek for dust suppression; and
- Storage and use of fuel for improvement activities with facility to be located at Remus Creek.

Following screening by the NIRB, the following activities were excluded by Applicant from the project scope:

- Movement of the temporary 24-person camp from Blacktop Creek to West Remus Creek, with removal of camp at completion of road construction works;
- Use of top load waste incinerator for incineration of combustible wastes at the temporary
- camp; and
- Disposal of sewage and grey water in sewage lagoon from temporary camp activities.

Scope

This application for an amendment to the current licence was reviewed by NWB technical staff and intervening parties, including DFO and CIRNAC. The Application was found to be technically complete with minor comments being brought forward by interested parties, and addressed by the Applicant.

The Project for which this Amendment No. 1 is issued is classified as a "Other Undertaking" in accordance with Schedule 1, Item 8 of the *Nunavut Waters Regulations*[2].

There were no concerns expressed during the review period with respect to the amount of water requested or the manner in which it would be used as long as there are proper measures in place to minimize the risks of water-bodies potential drawn down in accordance with Part C, Item 2 of the existing Licence.

Taking into account the information presented in the application and considering interveners' comments, the Board has included, under Part C, Item 1 of this amendment, authorizes the construction of a haul road and water crossing over Blacktop Creek and the development of a new quarry.

[2] SOR-2013-69.

# NUNAVUT WATER BOARD
WATER LICENCE AMENDMENT No.1

**Licence No. 8BC-EUR1621 Amendment No. 1**

Pursuant to the *Nunavut Waters and Nunavut Surface Rights Tribunal Act* and the *Agreement Between the Inuit of the Nunavut Settlement Area and Her Majesty the Queen in right of Canada*, the Nunavut Water Board, hereinafter referred to as the Board, hereby grants to

**ENVIRONMENT AND CLIMATE CHANGE CANADA**

(Licensee)

**335 RIVER ROAD, OTTAWA, ON K1V 1C7**

(Mailing Address)

hereinafter called the Licensee, the right to alter, divert or otherwise use water or dispose of Waste for a period subject to restrictions and conditions contained within this Licence Amendment:

| | |
|---|---|
| Licence Number/Type: | **8BC-EUR1621 AMENDMENT NO. 1 / TYPE "B"** |
| Water Management Area: | **NANSEN AND EUREKA SOUNDS WATERSHED No.59** |
| Location: | **QIKIQTANI REGION, NUNAVUT** |
| Classification: | **OTHER UNDERTAKING** |
| Purpose: | **USE OF WATER AND DEPOSIT OF WASTE** |
| Quantity of Water use not to Exceed: | **10,000 CUBIC METRES PER ANNUM AT A MAXIMUM RATE OF 299 CUBIC METRES PER DAY** |
| Date of Licence Issuance: | **AUGUST 11, 2016** |
| Expiry of Licence: | **AUGUST 10, 2021** |

This Licence amendment, issued and recorded at Gjoa Haven, Nunavut, includes and is subject to the annexed conditions.

**Lootie Toomasie**
**Nunavut Water Board, Chair**

**LICENCE AMENDMENT No. 1**

**The Licence shall be amended to indicate the following:**

# DECISION

**WATER LICENCE NUMBER: 8BC-EUR1621**

This is the decision of the Nunavut Water Board (NWB) with respect to an application dated June 14, 2018 for a Water Licence Amendment made by:

**ENVIRONMENT AND CLIMATE CHANGE CANADA**

to allow for the use of water for dust suppression and construction of a water crossing during operations and routine maintenance, runaway surface repair and construction of a new multi-purpose building at the Environment and Climate Change Canada's Eureka High Arctic Weather Station (HAWS), located on Ellesmere Island within the Qikiqtani Region, Nunavut, generally located at the geographical coordinates as follows:

Project Extents: Maximum Latitude: 79° 56' 22" N Maximum Longitude: 85° 19' 04" W
Minimum Latitude: 79° 56' 02" N Minimum Longitude: 85° 21' 32" W

## PART C: CONDITIONS APPLYING TO WATER USE

Amend Item 1 to Read

The Licensee shall obtain all fresh Water for all purposes under this Licence, including the temporary construction camp, through the Water Supply Facility and from West Remus Creek for dust suppression, shall not exceed ten thousand (10,000) cubic metres *per year*, at a rate not exceeding two hundred and ninety-nine (299) cubic metres *per day*.

## PART E: CONDITIONS APPLYING TO CAMPS, ACCESS INFRASTRUCTURES AND OPERATIONS

Amend Item 3 to Read

All surface runoff and/or discharge from drainage management systems, during the construction of any facilities and infrastructure associated with this project, including from quarry development at Monitoring Program Station EUR-5, referred to in Part J, Item 1, shall not exceed the following Effluent quality limits:

| Parameter | Maximum Concentration of any Grab Sample |
|---|---|
| Total Suspended Solids | 50 mg/L |
| Oil and Grease | 15 mg/L and no visible sheen |
| pH | Between 6.0 and 9.5 |

Insert Item 10

The Licensee shall implement the Plan entitled "Quarry Operation Plan, West Remus Quarry, Eureka, Nunavut", Nuna East Ltd., dated February 16, 2018, having been approved by the Board with the issuance of this Amendment.

Insert Item 11

The Licensee shall, during periods of flow and following a major precipitation event, conduct water quality testing on a monthly basis, of any significant water seeps in contact with the roads, earthworks and any flows originating from quarries for criteria listed under Part E, Item 3.

Insert Item 12

The Licensee shall locate stream crossings to minimize approach grades. Approaches shall be stabilized during construction and upon completion of the project, to control runoff, erosion and subsequent siltation to any water body.

Insert Item 13

The Licensee shall limit any in-stream activity to low water periods. In-stream activity is prohibited during fish migration.

Insert Item 14

The Licensee shall not cut any stream bank or remove any material from below the ordinary High Water Mark of any water body.

Insert Item 15

Sediment and erosion measures must be used to mitigate the deposition of debris and sediment into or onto any Water body during the construction and operation. These materials shall be disposed at a distance of at least thirty one (31) metres from the ordinary High Water Mark in such a fashion that they do not enter Water.

Insert Item 16

The Licensee shall maintain a minimum of thirty-one (31) metres undisturbed buffer zone between the periphery of quarry sites and the ordinary High Water Mark of any water body unless otherwise approved by the Bard in writing.

Insert Item 17

The Licensee shall not excavate and/or remove material from the quarry beyond a depth of one (1) metre above the ordinary High Water Mark or above the groundwater table, to prevent the potential contamination of groundwater.

## PART J: CONDITIONS APPLYING TO THE MONITORING PROGRAM

Amend Item 2 to Read

The Licensee shall measure and record in cubic metres, the daily, monthly and annual quantities of water pumped from Station Creek during the annual recharge of the Eureka water reservoir and from West Remus Creek during dust suppression at monitoring Program Station EUR-1.

**All remaining terms and conditions of the Licence 8BC-EUR1621 Type 'B" dated August 11, 2016, still apply.**

This Licence Amendment issued and recorded at Gjoa Haven, NU on July 18, 2018.

Approved by,

**Lootie Toomasie**
**Nunavut Water Board, Chair**

**SCREENING DECISION REPORT**
**NIRB FILE No.: 12XN020**

NPC File No.: 148746
*Related to NPC File No.: 148232*
INAC File No.: N2017N0017
NWB File No. 8BC-EUR1621

**June 1, 2018**

Following the Nunavut Impact Review Board's (NIRB or Board) assessment of all materials provided, the NIRB is recommending that a review of Environment and Climate Change Canada's "Amended Land Use Permit application for Eureka Weather Station" is not required pursuant to paragraph 92(1)(a) of the *Nunavut Planning and Project Assessment Act*, S.C. 2013, c. 14, s. 2 (*NuPPAA*).

Subject to the Proponent's compliance with the terms and conditions as set out in below, the NIRB is of the view that the project proposal is not likely to cause significant public concerns, and it is unlikely to result in significant adverse environmental and social impacts. The NIRB therefore recommends that the responsible Minister accepts this Screening Decision Report.

## OUTLINE OF SCREENING DECISION REPORT



## REGULATORY FRAMEWORK

The primary objectives of the NIRB are set out in Section 12.2.5 of the *Agreement between the Inuit of the Nunavut Settlement Area and Her Majesty the Queen in right of Canada* (*Nunavut Agreement*) and are confirmed by section 23 of the *NuPPAA*:

> *Nunavut Agreement*, Article 12, Section 12.2.5: In carrying out its functions, the primary objectives of NIRB shall be at all times to protect and promote the

existing and future well-being of the residents and communities of the Nunavut Settlement Area, and to protect the ecosystemic integrity of the Nunavut Settlement Area. NIRB shall take into account the well-being of the residents of Canada outside the Nunavut Settlement Area.

The purpose of screening is provided for under section 88 of the *NuPPAA*:

> *NuPPAA*, s. 88: The purpose of screening a project is to determine whether the project has the potential to result in significant ecosystemic or socio-economic impacts and, accordingly, whether it requires a review by the Board…

To determine whether a review of a project is required, the NIRB is guided by the considerations as set out under subsection 89(1) of *NuPPAA*:

> *NuPPAA*, s. 89(1): The Board must be guided by the following considerations when it is called on to determine, on the completion of a screening, whether a review of the project is required:
>
> (a) a review is required if, in the Board's opinion,
>
> i. the project may have significant adverse ecosystemic or socio-economic impacts or significant adverse impacts on wildlife habitat or Inuit harvest activities,
> ii. the project will cause significant public concern, or
> iii. the project involves technological innovations, the effects of which are unknown; and
>
> (b) a review is not required if, in the Board's opinion,
>
> i. the project is unlikely to cause significant public concern, and
> ii. its adverse ecosystemic and socioeconomic impacts are unlikely to be significant, or are highly predictable and can be adequately mitigated by known technologies.

It is noted that subsection 89(2) of the *NuPPAA* provides that the considerations set out in paragraph 89(1)(a) prevail over those set out in paragraph 89(1)(b) of the *NuPPAA*.

As set out under subsection 92(1) of the *NuPPAA*, upon conclusion of the screening process, the Board must provide its written report the Minister:

> *NuPPAA*, s. 92(1): The Board must submit a written report to the responsible Minister containing a description of the project that specifies its scope and indicating that:
>
> (a) a review of the project is not required;
>
> (b) a review of the project is required; or
>
> (c) the project should be modified or abandoned.

Where the NIRB determines that a project may be carried out without a review, the NIRB has the discretion to recommend specific terms and conditions to be attached to any approval of the project proposal pursuant to paragraph 92(2)(a) of *NuPPAA* as follows:

*NuPPAA,* s. 92(2) In its report, the Board may also

(a) recommend specific terms and conditions to apply in respect of a project that it determines may be carried out without a review.

## PROJECT REFERRAL

On March 7, 2018 the NIRB received a referral to screen Environment and Climate Change Canada's (ECCC) "Amended Land Use Permit application for Eureka Weather Station" project proposal from the Nunavut Planning Commission (NPC or Commission), with an accompanying positive conformity determination with the North Baffin Regional Land Use Plan. The NPC noted that the previous conformity determination issued on April 19, 2012 and April 14, 2016 for the activities associated with the current proposal continues to apply and has determined that the project proposal is a significant modification to the project because of construction of the new road, water stream crossings, work camp relocation and new quarry site.

Pursuant to Article 12, Sections 12.4.1 and 12.4.4 of the *Nunavut Agreement* and section 87 of the *NuPPAA*, the NIRB commenced screening this project proposal. Due to the proposal containing activities that were sufficiently related to previously assessed activities under NIRB file number **12XN020**, the NIRB viewed this project proposal as an amendment to the previously screened project and assigned this proposal with this previous file number. A summary of the previously screened project activities can be found in **Appendix A**.

## PROJECT OVERVIEW & THE NIRB ASSESSMENT PROCESS

### 1. Project Scope

The proposed "Amended Land Use Permit application for Eureka Weather Station" project is located within the Qikiqtani region, approximately 407 km northwest from Grise Fiord. The Proponent intends to amend the scope of activities, as the previously approved Black Top Creek Quarry site was determined not a viable source of granular material for the proposed Eureka Recapitalization Runway Project. ECCC proposes to develop a new quarry site located at West Remus Creek and an associated access road from the Eureka Weather Station to the new quarry site with the construction program of the road proposed to take place from June 2018 to October 2018. The scope of activities previously approved for this ongoing infrastructure improvement (NIRB File No. 12XN020) has been included within **Appendix A**.

As required under subsection 86(1) of the *NuPPAA*, the Board accepts the scope of the "Amended Land Use Permit application for Eureka Weather Station" project as set out by ECCC in the proposal. The scope of the project proposal includes the following undertakings, works, or activities:

- Upgrade an existing all-terrain vehicle (ATV) path/trail to a six (6) metre wide permanent road from West Remus Creek to the current Eureka runway for a total length of approximately 12 kilometres (km);
- Development of a new borrow area located at West Remus Creek for use of up to 75,000 cubic metres ($m^3$) aggregate to construct road;
- Placement of culverts along to road to drain melt runoff including two (2) Arch culverts in Blacktop Creek to create a culvert bridge;

- Movement of crusher from Blacktop Creek to West Remus Creek; and
- Storage and use of fuel for improvement activities with facility to be located at Remus Creek.

At this time, the NIRB has identified no additional works or activities in relation to the project proposal. As a result, the NIRB will proceed with screening the project based on the scope as described above.

## 2. Inclusion or Exclusion to Scoping List

In response to comments submitted regarding the proposed project (see Public Comments and Concerns section below), on May 15, 2018 the Proponent noted that its plans had changed; the proposed temporary camp at West Remus Creek would not be constructed, workers would be based out of the existing camp at Blacktop Creek instead, and workers would use the existing Eureka Weather Station water and sewage facilities.

Following consideration of comments received from the Proponent, the NIRB determined that an exclusion of these specific works or activities from the scope of the project was appropriate. As such any activities associated with the development of a new temporary camp at West Remus Creek has been excluded from the scope of this screening and, should similar activities be proposed in future, they should be considered as a significant amendment to the project and required to undergo a separate assessment by the NIRB.

Following identification of the scope of the project as set out above, the Proponent's work plan was updated during the screening process subsequent to the initial application, resulting in the following works/activities being excluded from the scope of the project:

- Movement of the temporary 24 person camp from Blacktop Creek to West Remus Creek, with removal of camp at completion of road construction works;
- Use of water from Station Creek and Remus Creek for domestic purposes;
- Use of top load waste incinerator for incineration of combustible wastes at the temporary camp; and
- Disposal of sewage and grey water in sewage lagoon from temporary camp activities.

The Proponent has indicated that their intention is to use the previously approved existing camp at Blacktop Creek and existing water and sewage facilities at the Eureka Weather Station instead of the development of the temporary camp as previously requested at Remus Creek. As such any activities associated with the development of a new temporary camp at West Remus Creek has been excluded from the scope of this screening and, should similar activities be proposed in future, they should be considered as a significant amendment to the project and required to undergo a separate assessment by the NIRB.

## 3. Key Stages of the Screening Process

The following key stages were completed:

| Date | Stage |
|---|---|
| March 7, 2018 | Receipt of project proposal and positive conformity determination (Northern Baffin Land Use Plan) from the NPC |
| March 7, 2018 | Information request |
| March 26, 2018 | Proponent responded to information request(s) |
| March 26, 2018 | Scoping pursuant to subsection 86(1) of the *NuPPAA* |
| April 3, 2018 | Public engagement and comment request |
| April 24, 2018 | Receipt of public comments |
| May 1, 2018 | Proponent provided with an opportunity to address comments/concerns raised by public |
| May 2, 2018 | Ministerial extension requested from the Minister of Indigenous and Northern Affairs Canada, Government of Canada |
| May 15, 2018 | Proponent responded to comments/concerns raised by public |

## 4. Public Comments and Concerns

Notice regarding the NIRB's screening of this project proposal was distributed on April 3, 2018 to community organizations in Grise Fiord, as well as to relevant federal and territorial government agencies, Inuit organizations and other parties. The NIRB requested that interested parties review the proposal and provide the Board with any comments or concerns by April 24, 2018 regarding:

- Whether the project proposal is likely to arouse significant public concern; and if so, why;
- Whether the project proposal is likely to cause significant adverse eco-systemic or socio-economic effects; and if so, why;
- Whether the project proposal is likely to cause significant adverse impacts on wildlife habitat or Inuit harvest activities; if so, why;
- Whether the project proposal is of a type where the potential adverse effects are highly predictable and mitigable with known technology, (please provide any recommended mitigation measures); and
- Any matter of importance to the Party related to the project proposal.

The following is a summary of the comments and concerns received by the NIRB:

**Government of Nunavut (GN)**

*Camp Services*

- The 24 person tent camp that is proposed to be established at the site for the project and will house 50 contract workers would require review under the Public Health Act as the camp would be providing food, water and waste systems to service the camp.

*Wildlife Mitigation*

- Concerns the project potentially would result in wildlife disturbance.
- Minimal information on the area with respect to the composition of plant and animal communities and population abundances, and recommended the Proponent undertake

localized surveying to determine the composition of local plant and animal species and their habitats that may be affected by project construction and operations.

- Recommended the Proponent take precautions to ensure no undue stress to wildlife is caused from the project activities by providing suggested mitigation measures for wildlife in general, caribou and raptors.
- Concerns noted that the proposed project area may overlap with or affect Polar Bear denning activities or sites. Further, concerns were noted that the project activities could result in Polar Bear encounters and disturbance of denning sites. Recommended mitigation measures in the event Polar Bears and/or dens are encountered during the project activities.
- Concern that earth moving (e.g. blasting, grading, piling gravel, and other debris) activities may influence snow drifting, drift direction, drift thickness, etc. which may affect whether Polar Bears would find suitable denning habitat or not; and recommended that before any activities are conducted, the Government of Nunavut - Department of Environment (GN-DoE) be consulted.

*Species at Risk*

- Limited information on the presence of *Porsild's Bryum* which is listed as a threatened species under the *Species at Risk Act* and recommended the Proponent conduct a survey of the project location. If any *Porsild's Bryum* colonies are identified, the Proponent would be required to contact the GN-DoE prior to commencing construction activities.

*Archaeological Resources*

- Concern that the new infrastructure components as proposed would be in conflict with a number of archaeological sites in the area as identified in the Archaeological Impact Assessment.
- Recommended the Proponent applies for a Class 2 permit in order to mitigate any potential impact to archaeological sites located within the project footprint.

**Indigenous and Northern Affairs Canada (INAC)**

- No comments or additional terms and conditions to offer at this time.

## 5. Comments and Concerns with respect to Inuit Qaujimaningit, Traditional, and Community Knowledge

No concerns or comments were received with respect to Inuit Qaujimaningit or traditional and community knowledge in relation to the proposed project.

## 6. Proponent's Response to Public Comments and Concerns

The following is a summary of the Proponent's response to concerns as received on May 15, 2018:

- In response to concerns regarding the camp at West Remus Creek, the Proponent noted it no longer plans to establish a temporary camp but to use existing approved camp facilities.

- In response to concerns regarding wildlife disturbance, the Proponent noted that an Environmental Impact Assessment was completed for the proposed project and included mitigation measures for wildlife.
- In response to concerns regarding the lack of baseline information on vegetation and animals in the proposed project area, the Proponent has agreed to develop a Wildlife Management Plan (WMP) which will include conducting a reconnaissance survey for Polar Bears, caribou, raptors, migratory birds, and Species at Risk prior to commencing construction work.
- In response to concerns regarding Polar Bears and Polar Bear denning, the Proponent noted that site records indicate Polar Bears are very rare in the area.
- In response to concerns regarding the potential presence of *Porsild's Bryum*, the Proponent notes that the conditions in the proposed project area make it unlikely that *Porsild's Bryum* is present, and that after discussion the Government of Nunavut has agreed. Environment and Climate Change Canada has committed to conducting a reconnaissance survey to identify any that might be present.
- In response to concerns regarding archeological resources, the Proponent has committed to hiring the archeologist who conducted the Archeological Impact Assessment of the project area to identify sites to the contractor prior to construction work. The archeologist has applied for a Class 2 permit.

## 7. Time of Report Extension

As a result of the time required to allow parties sufficient time to comment on the project as well as let the Proponent provide a response to the comments, the NIRB was not able to provide its screening decision report to the responsible Minister within 45 days as required by Article 12, Section 12.4.5 of the *Nunavut Agreement* and subsection 92(3) of the *NuPPAA*. Therefore, on May 2, 2018 the NIRB wrote to the Minister of Crown – Indigenous Relations and Northern Affairs, Government of Canada, seeking an extension to the 45-day timeline for the provision of the Board's Report.

## ASSESSMENT OF THE PROJECT PROPOSAL IN ACCORDANCE WITH PART 3 OF *NUPPAA*

In determining whether a review of the project is required, the Board considered whether the project proposal had potential to result in significant ecosystemic or socio-economic impacts.

Accordingly, the assessment of impact significance was based on the analysis of those factors that are set out under section 90 of the *NuPPAA*. The Board took particular care to take into account Inuit Qaujimaningit, traditional and community knowledge in carrying out its assessment and determination of the significance of impacts.

The following is a summary of the Board's assessment of the factors that are relevant to the determination of significant impacts with respect of this project proposal:

1. *The size of the geographic area, including the size of wildlife habitats, likely to be affected by the impacts.*

   The proposed road and quarry project involves widening an existing 9 kilometre (km) long all-terrain vehicle (ATV) trail from the Eureka airstrip to the proposed new quarry site at Remus Creek in order to provide aggregate for the upgrading of the airstrip. The proposed quarry site has a surface area of approximately 36 hectares (0.36 square kilometres [$km^2$]) and is located in an area of minimal to no vegetation and poor wildlife habitat, and the road is located on previously disturbed terrain, thus the anticipated impacts on wildlife habitat are considered to be minimal. Remus Creek and Blacktop Creek are considered seasonal melt-water streams and are unlikely to be fish-bearing.

2. *The ecosystemic sensitivity of that area.*

   The proposed project would occur in an area with no particular identified ecosystemic sensitivity. However, the area has been identified by the Proponent and/or from NPC's online mapping data as having value and priority to the local community for:

   i. Terrestrial wildlife including muskox;
   ii. Migratory birds and non-migratory birds;
   iii. Polar Bears; and
   iv. *Porsild's Bryum* moss.

   Based on the Proponent's data collected from the Eureka Weather Station, the presence of Polar Bears in the area is rare, while the conditions for the growth of *Porsild's Bryum* is highly unlikely in the proposed quarry location. Muskox are frequently observed in the area.

3. *The historical, cultural and archaeological significance of that area.*

   The Proponent has indicated that there are a number of known areas of historical, cultural and archaeological significance in the vicinity of the project area. Should the project be approved to proceed, the Proponent has committed to avoiding identified archaeological resources in the vicinity of the project area and would be required to contact the Government of Nunavut-Department of Culture and Heritage if any additional sites of historical, cultural or archaeological significance are encountered.

4. *The size of the human and the animal populations likely to be affected by the impacts.*

   The proposed project would occur at a location approximately 400 kilometres from Grise Fiord, the nearest community; as such, no human populations are likely to be affected by project impacts. However, it was noted during the commenting period that there is potential for impact to the Polar Bears and caribou, which could result in adverse impacts to traditional pursuits such as caribou and Polar Bear hunting. No other specific animal populations have been identified as likely to be affected by potential project impacts.

5. *The nature, magnitude and complexity of the impacts; the probability of the impacts occurring; the frequency and duration of the impacts; and the reversibility or irreversibility of the impacts.*

   As the "Amended Land Use Permit application for Eureka Weather Station" project would involve quarrying and construction activities, including a permanent haul road and water crossing, there is potential for impacts due to dust, sedimentation, and habitat disturbance for the duration of the quarry and aggregate hauling activities. However, based on past evidence of similar scope of activities, the potential adverse impacts may be of low magnitude, reversible and mitigable with due care.

6. *The cumulative impacts that could result from the impacts of the project combined with those of any other project that has been carried out, is being carried out or is likely to be carried out.*
   The proposed project would take place within a 100 kilometre radius to a number of other projects that are currently active, in addition to other projects proposed and below. However, it is noted that this project is not likely to result in residual or cumulative impacts. Terms and conditions recommended for each of these projects are expected to reduce any residual impacts, and as such would limit or eliminate the potential for cumulative effects to occur.

**Table 1: Project List**

| NIRB Project Number | Project Title | Project Type |
|---|---|---|
| ***Active Projects*** | | |
| 08YN010 | Ice Dynamics and Cryospheric Changes in Northern Canada | Research |
| 17UN035 | Bathurst High Arctic Remediation | Restoration/Remediation |
| 17UN052 | Qausuittuq National Park Caribou Habitat Restoration Phase 1 | Restoration/Remediation |
| ***Past Projects*** | | |
| 16DN017 | Operation Nevus 2016 | Defense |
| 16YN043 | Past climate reconstruction using annually-layered carbonate | Research |
| 16DN061 | NOREX 17 | Defense |
| 17YN019 | Permafrost-active layer dynamics and feedbacks with climate forcing in ice-rich sediments | Research |
| 17YN039 | Multidisciplinary Investigation of Salt Diapirs | Research |
| 17CN051 | Arctic Kingdom – Redbull | Filming and Camp |

7. *Any other factor that the Board considers relevant to the assessment of the significance of impacts.*

   No other specific factors have been identified as relevant to the assessment of this project proposal.

## VIEWS OF THE BOARD

In considering the factors as set out above in the screening of the project proposal, the NIRB has identified a number of issues below and respectfully provide the following views regarding whether or not the proposed project has the potential to result in significant impacts. In addition, the NIRB has proposed terms and conditions that would mitigate the potential adverse impacts identified.

**Administrative Conditions:**

To encourage compliance with applicable regulatory requirements and assist the Board and responsible authorities with compliance and effects monitoring for project activities, the Board has previously recommended terms and conditions 1 through 4, and which continue to apply to the current project proposal. The Board is also recommending term and condition 48 to ensure complete reference to applicable regulatory requirements.

The Board would also note that, as justified in its previous decision (NIRB File No. 12XN020 dated May 30, 2012 and September 22, 2015), terms and conditions 5 through 47 remain applicable to the project as outlined below, and no additional terms and conditions are required for the project.

**Ecosystem, wildlife habitat and Inuit harvesting activities:**

**Issue 1:** Potential adverse impacts to wildlife, migratory birds and non-migratory birds and associated wildlife habitat from construction of the road, quarry activities, and aggregate hauling as well as the increase in noise from the construction activities.

Board views: As discussed above in the assessment of factors relevant to this project proposal, the potential for impact(s) is applicable to previously disturbed area for the construction of the road and a geographically small area (36 hectares) for the quarry site. The quarry location has poor vegetation cover and is unlikely to be used for nesting nor for feeding by muskox or other wildlife in the area. Further, the Proponent noted within the submitted Environmental Impact Assessment that there is the possibility for disturbance of bird nests during operations. However, due to the short and intermittent nature of the proposed activities, as well as the operational procedures that would be adhered to by the Proponent, potential adverse impacts to wildlife and birds would be expected to be minimal and temporary only.

The Proponent would also be required to follow the *Migratory Birds Convention Act*, *Migratory Birds* Regulations, *Species at Risk Act*, and the *Wildlife Act (Nunavut),* (see Regulatory Requirements section).

Recommended Mitigation Measures: The Proponent has committed to updating its wildlife management plan to include concerns expressed during the comment period. The Board has previously recommended terms and conditions to mitigate potential adverse impacts to wildlife and wildlife habitats, specifically: 8, 13, 19 through 24, and 35 which continue to apply to the current project proposal.

**Issue 2:** Potential adverse impacts to surface water quality and quantity, fish and fish habitat, vegetation, land and soil quality from quarrying and road construction activities, storage and use of fuel and chemicals, waste storage and disposal, and aggregate hauling.

Board views: There is the potential for the project to adversely impact surface water quality, fish and fish habitat, vegetation, land and soil quality from fuel spills during establishment and/or operation of the road, quarrying activities, and movement of machinery, fuel, and supplies, particularly in sections of the project that are adjacent to or across waterbodies. The potential for impacts is applicable to small geographic areas within the project footprint and the probability of impacts occurring is considered to be low, with potential adverse effects anticipated to be low in magnitude and reversible in nature. The two (2) streams closest to the project activities (Blacktop Creek and Remus Creek) are seasonal meltwater streams with no observed fish population, and the project has been deemed by Fisheries and Oceans Canada (DFO) to not affect fish or fish habitat and thus not require permitting from DFO.

The Proponent has provided a comprehensive Fuel Spill Emergency Plan which includes storage measures, spill response measures, equipment requirements, and overall handling procedures for the management of fuel and chemicals (see Proponent Commitments section). Additionally, the Proponent has provided Quarry Operations Plan which includes details relating to minimizing potential effects on water from sedimentation (see Proponent Commitments section). In addition to the Proponent's proposed mitigation measures, it is expected that standard operational considerations would mitigate any potential adverse impacts to the surface water quality and quantity, and fish and fish habitat in the direct project area and areas adjacent to the proposed project (see Proponent Commitments section).

The Proponent has an existing water licence from the Nunavut Water Board for the water usage activities and fuel storage. In addition, the Proponent would also be required to follow the *Fisheries Act,* the *Transportation of Dangerous Goods Regulations*, *Transportation of Dangerous Goods Act*, and the *Canadian Environmental Protection Act* (see Regulatory Requirements section).

Recommended Mitigation Measures: The Board previously issued terms and conditions to reduce adverse impacts from fuel/chemical spill hazards, waste management and disposal, and sedimentation resulting from quarrying and construction activities by issuing terms and conditions 5 through 6, 11, 12, 14 through 18, 33, 34, 36, 39, and 41 through 46, which continue to apply to the project.

**Issue 3:** Potential adverse impacts to air quality from the road development and use, quarry development and operations, use of heavy equipment, and associated noise and dust.

Board views: There is potential for adverse impacts to air quality from site preparation, use of heavy equipment and machinery, quarrying activities associated with the project, noise, and dust generation, which would be limited to within the project footprint with a low probability of extending beyond the geographic area. The potential adverse impacts to air quality are considered to be of low magnitude, short-term, and reversible.

Recommended Mitigation Measures: It is recommended that the potential adverse impacts may be mitigated by measures such as ensuring that the Proponent minimize dust with the addition of dust suppressants and minimize emission from vehicles. The Board previously recommended the following terms and conditions to mitigate the potential adverse impacts to air quality: 30, 35, 36, and 47, which continue to apply to the project.

**Socio-economic effects on northerners:**

**Issue 4:** Potential adverse impacts to archaeological sites from quarry and construction activities.

Board Views: The Proponent is proposing to work in an area of known archeological sites which may cause potential negative impacts. The Proponent has committed to perform an archeological survey (see Proponent Commitments section) and is required to contact the Government of Nunavut – Department of Culture and Heritage when encountering historical sites and is required to follow the *Nunavut Act* (as recommended in Regulatory Requirements section).

Recommended Mitigation Measures: Term and condition 40 was previously recommended to ensure that available Inuit Qaujimaningit can inform project activities, and reduce the potential for negative impacts occurring to any additional historical sites, which continue to apply for this project proposal.

**Significant public concern:**

**Issue 5:** No significant public concern was expressed during the public commenting period for this file.

Board Views: Follow up consultation and involvement of local community members is expected to mitigate any potential for public concern resulting from project activities. In addition, it is recommended that the Proponent considers hiring local people for the project activities.

Recommended Mitigation Measures: Term and condition 40 was previously recommended to ensure that the affected community and organizations are informed about the project proposal, and to provide community members with information to ensure a successful local hiring opportunity, which continue to apply for this project proposal. In addition, the Board is recommending new term and condition 49 to ensure quarry boundaries are clearly visible to land users.

**Technological innovations for which the effects are unknown:**

No specific issues have been identified associated with this project proposal.

In considering the above factors and subject to the Proponent's compliance with the terms and conditions necessary to mitigate against the potential adverse environmental and social effects, the Board is of the view that the proposed project is unlikely to cause significant public concern and its adverse ecosystemic and socioeconomic impacts are unlikely to be significant, or are highly predictable and can be adequately mitigated by known technologies.

The following terms and conditions were previously issued by the NIRB in the May 30, 2012 and September 22, 2015 Screening Decision Report(s) for File No. 12XN020***, and continue to apply to the "Amended Land Use Permit application for Eureka Weather Station" project*:**

**General**

1. Environment Canada (the Proponent) shall maintain a copy of the Project Terms and Conditions at the site of operation at all times.
2. The Proponent shall forward copies of all permits obtained and required for this project to the Nunavut Impact Review Board (NIRB) prior to the commencement of the project.
3. The Proponent shall operate in accordance with all commitments stated in correspondence and materials provided as a part of the current application package:
    a. NIRB Part 1 Form, April 5, 2012;
    b. NPC Application for Conformity, April 16, 2012;
    c. AANDC Land Use Permit Application, April 4, 2012;
    d. Operations and Maintenance for Drinking Water, Sewage, Solid waste Disposal and Waste Treatment Facilities, January 2011; and
    e. Operating procedures for Eureka Land Reserve, March 1, 2011.
4. The Proponent shall operate the site in accordance with all applicable Acts, Regulations and Guidelines.

**Water Use**

5. The Proponent shall not extract water from any fish-bearing waterbody unless the water intake hose is equipped with a screen of appropriate mesh size to ensure that there is no entrapment of fish. Small lakes or streams should not be used for water withdrawal unless approved by the Nunavut Water Board.
6. The Proponent shall not use water, including constructing or disturbing any stream, lakebed or the banks of any definable water course unless approved by the Nunavut Water Board.

**Waste Disposal/Incineration**

7. The Proponent shall incinerate all combustible wastes daily, and remove the ash from incineration activities and non-combustible wastes from the project site to an approved facility for disposal.
8. The Proponent shall keep all garbage and debris in bags placed in a covered metal container or equivalent until disposed of at an approved facility. All such wastes shall be kept inaccessible to wildlife at all times.
9. The Proponent shall ensure that the incineration of combustible camp wastes comply with the *Canadian Wide Standards for Dioxins and Furans,* and the *Canadian Wide Standards for Mercury*.
10. The Proponent shall ensure that no waste oil/grease is incinerated on site.

11. The Proponent shall remove and treat hydrocarbon contaminated soils/snow on site or transport them to an approved disposal site for treatment.

**Fuel and Chemical Storage**

12. The Proponent shall ensure that storage of fuel and hazardous materials and re-fuelling of project equipment is conducted at a minimum of thirty-one (31) metres away from the high water mark of any water body and in such a manner as to prevent their release into the environment.
13. The Proponent shall store all fuel and chemicals in such a manner that they are inaccessible to wildlife.
14. The Proponent shall use adequate secondary containment or a surface liner (e.g. self-supporting insta-berms and fold-a-tanks) when storing barrelled fuel and chemicals at all locations. Appropriate spill response equipment and clean-up materials (e.g., shovels, pumps, barrels, drip pans, and absorbents) must be readily available during any transfer of fuel or hazardous substances, as well as at fuel caches, vehicle-maintenance areas and drill sites. Spill kits and secondary containment structures should accommodate 110% of the capacity of the largest fuel storage container within the cache.
15. The Proponent shall inspect and document the condition of all large fuel tanks on a weekly basis. All fuel and chemical storage containers must be clearly marked with the Proponent's name and examined for leaks immediately upon delivery.
16. The Proponent shall flag all fuel caches on site so they remain visible in the winter months.
17. The Proponent shall use drip pans or other equivalent device when refueling equipment on-site. The Proponent shall ensure that appropriate spill kit (e.g., shovels, absorbents, etc.) must be readily available during any transfer of fuel.
18. The Proponent shall ensure that all personnel are properly trained in fuel and hazardous waste handling procedures, as well as spill response procedures. All spills of fuel or other deleterious materials of any amount must be reported immediately to the 24 hour Spill Line at (867) 920-8130.

**Wildlife - General**

19. The Proponent shall ensure that there is no damage to wildlife habitat in conducting this operation.
20. The Proponent shall not harass wildlife. This includes persistently worrying or chasing animals, or disturbing large groups of animals. The Proponent shall not hunt or fish, unless proper Nunavut authorizations have been acquired.
21. The Proponent shall ensure that all project personnel are made aware of the measures to protect wildlife and are provided with training and/or advice on how to implement these measures.

**Migratory Birds and Raptors Disturbance**

22. The Proponent shall not disturb or destroy the nests or eggs of any birds. If nests are encountered and/or identified, the Proponent shall take precaution to avoid further interaction and or disturbance (e.g., a 100 metre buffer around the nests). If active nests of any birds are

discovered (i.e., with eggs or young), the Proponent shall avoid these areas until nesting is complete and the young have left the nest.

**Aircraft Flight Restrictions**

23. The Proponent shall restrict aircraft/helicopter activity related to the project to a minimum altitude of 610 metres above ground level unless there is a specific requirement for low-level flying, which does not disturb wildlife and migratory birds.
24. The Proponent shall ensure that aircraft maintain a vertical distance of 1,000 metres and a horizontal distance of 1,500 metres from any observed groups (colonies) of migratory birds. Aircraft should avoid critical and sensitive wildlife areas at all times by choosing alternate flight corridors.
25. The Proponent shall ensure that aircraft/helicopter do not, unless for emergency, touch-down in areas where wildlife are present.
26. The Proponent shall advise all pilots of relevant flight restrictions and enforce their application over the project area, including flight paths to/from the project area.

**Landfarms**

27. The Proponent shall only treat petroleum and hydrocarbon contaminated soils using the landfarm facility. Materials contaminated with other substances such as glycol and heavy metals are not to be stored at the landfarm and shall only be disposed of at an authorized facility.
28. The Proponent shall ensure required standards, set out in the Nunavut Water Board's Water Licence for this project are met prior to any discharge of collected water in the retention cell.
29. The Proponent shall ensure that the equipment used in the landfarm operation for aeration, have been cleaned off within the landfarm facilities prior to exiting to prevent contaminated soil transfer.
30. The Proponent shall take appropriate dust suppression measures when conducting soil turning and removal.
31. All operation personnel shall be adequately trained prior to commencement of any operation in the landfarm facility. Operational personnel should also be trained in the operational guidelines and commitments made by the Proponent for this project.
32. The Proponent shall ensure that all on site personnel are properly trained in fuel and hazardous waste handling procedures as well as spill response procedures. All spills of fuel or other deleterious materials of any amount must be reported immediately to the 24 hour Spill Line at (867) 920-8130.

**Access Road**

33. The Proponent shall not move any equipment or vehicles unless the ground surface is in a state capable of fully supporting the equipment or vehicles without rutting or gouging. Overland travel of equipment or vehicles must be suspended if rutting occurs.
34. The Proponent shall implement suitable erosion and sediment suppression measures on disturbed areas in order to prevent sediment from entering any water body.

35. All road vehicles must be fitted with standard and well-maintained noise suppression devices and engine idling is to be minimized.

36. The Proponent shall use water or other non-toxic and biodegradable additives for dust suppression as necessary to maintain ambient air quality without causing water to pool or runoff.

**Temporary Camps**

37. The Proponent shall ensure that all camps are located on gravel, sand or other durable land.

38. The Proponent shall not erect camps or store material on the surface ice of lakes or streams.

**Restoration of Disturbed Areas**

39. The Proponent shall remove all garbage, fuel and equipment upon abandonment.

**Other**

40. The Proponent should, to the extent possible, hire local people and consult with local residents regarding their activities in the region.

***(updated)*** **Aggregate Removal and Operations within Existing and New Quarries**

41. The Proponent shall not remove any material from below the ordinary high water mark of any lake or stream.

42. The Proponent shall not deposit or permit the deposit of sediment into any water body.

43. The Proponent shall ensure there is no obstruction of natural drainage, flooding or channel diversion from quarry/pit access, stockpiles, or other structures or facilities.

44. The Proponent shall ensure that silt fences/curtains are installed down gradient of any quarry activities.

45. The Proponent shall maintain an undisturbed buffer zone between the periphery of quarry sites and the high water mark of any water body that is of an adequate distance to ensure erosion control.

46. The Proponent shall locate screening and crushing equipment on stable ground, at a location with ready access to stockpiles.

47. The Proponent shall use water or other non-toxic and biodegradable additives for dust suppression as necessary to maintain ambient air quality without causing water to pool or runoff.

**In addition to the previously issued terms and conditions, the Board recommends the following project-specific terms and conditions:**

48. The Proponent shall operate in accordance with all commitments stated in correspondence provided to the Nunavut Planning Commission (NPC File No.: 148746), and the NIRB (Online Application Form, March 26, 2018; Response to Comments, May 15, 2018).

**Establishment of New Quarries**

49. The Proponent shall clearly stake and flag pit and quarry boundaries so they remain visible to other land users.

## MONITORING AND REPORTING REQUIREMENTS

*The Board has previously recommended the following on May 30, 2012 and September 22, 2015:*

**Annual Report**

1. (*updated*) The Proponent shall submit an annual report with copies provided to the Nunavut Impact Review Board by November 1 of each year between 2015 and 2022. The annual report must contain the following information:
    a. A summary of activities undertaken for the year, including a list of activities and when they were undertaken, as well as the approximate quantities of aggregate extracted each year.

## OTHER NIRB CONCERNS AND RECOMMENDATIONS

***In addition to the project-specific terms and conditions, the Board has previously recommended the following on May 30, 2012 and September 22, 2015:***

**Bear and Carnivore Safety**

1. (*updated*) The Proponent should review the Government of Nunavut's booklet on Bear Safety, which can be downloaded from this link: http://gov.nu.ca/sites/default/files/bear_safety_-_reducing_bear-people_conflicts_in_nunavut.pdf. Further information on bear/carnivore detection and deterrent techniques can be found in the "*Safety in Grizzly and Black Bear Country*" pamphlet, which can be downloaded from this link: http://www.enr.gov.nt.ca/sites/default/files/web_pdf_wd_bear_safety_brochure_1_may_2015.pdf.

   There are Polar Bear and grizzly bear safety resources available from the Bear Smart Society with videos on polar bear safety available in English, French, and Inuktitut at http://www.bearsmart.com/play/safety-in-polar-bear-country/. Information can also be obtained from Parks Canada's website on bear safety at the following link: http://www.pc.gc.ca/eng/pn-np/nu/quttinirpaaq/visit/visit6/d.aspx or in reviewing the "*Safety in Polar Bear Country*" pamphlet, which can be downloaded from the following link: *http://www.pc.gc.ca/eng/pn-np/nu/quttinirpaaq/visit/visit6/~/media/pn-np/nu/auyuittuq/pdf/shared/PolarBearSafety_English.ashx*.

2. Any problem wildlife or any interaction with carnivores should be reported immediately to the local Government of Nunavut - Department of Environment Conservation Office in Iqaluit (phone: (867) 924-6235).

**Incineration of Wastes**

3. The Proponent review Environment Canada's "Technical Document for Batch Waste Incineration", available at the following link: http://www.ec.gc.ca/gdd-mw/default.asp?lang=En&n=F53EDE13-1. The technical document provides information on appropriate incineration technologies, best management and operational practices, monitoring, and reporting.

**Species at Risk**

4. (*updated*) The Proponent review Environment and Climate Change Canada's "Environment Assessment Best Practice Guide for Wildlife at Risk in Canada", available at the following link: http://www.sararegistry.gc.ca/virtual_sara/files/policies/EA%20Best%20Practices%202004.pdf. The guide provides information to the Proponent on what is required when Wildlife at Risk, including *Species at Risk*, are encountered or affected by the project.

**Change in Project Scope**

5. (*updated*) Responsible authorities or Proponent shall notify the Nunavut Planning Commission (NPC) and the NIRB of any changes in operating plans or conditions, including phase advancement, associated with this project prior to any such change

**(*updated*) Indigenous and Northern Affairs Canada**

6. Indigenous and Northern Affairs Canada (INAC) impose mitigation measures, conditions and monitoring requirements pursuant to the Federal Land Use Permit, which require the Proponent to respect the sensitivities and importance of the area. These mitigation measures, conditions and monitoring requirements should be in regard to the location and area; type, location, capacity and operation of facilities; use, storage, handling and disposal of chemical or toxic material; wildlife and fisheries habitat; and petroleum fuel storage.

7. INAC consider the importance of conducting regular Land Use Inspections, pursuant to the authority of the Federal Land Use Permit, while the project is in operation. The Land Use Inspections should be focused on ensuring the Proponent is in compliance with the conditions imposed through the Federal Land Use Permit.

***The Board is currently also recommending the following:***

**Migratory Birds**

8. The Proponent review Canadian Wildlife Services' "Key migratory bird terrestrial habitat sites in the Northwest Territories and Nunavut", available at the following link: http://publications.gc.ca/site/eng/317630/publication.html and "Key marine habitat sites for migratory birds in Nunavut and the Northwest Territories", available at the following link: http://publications.gc.ca/site/eng/392824/publication.html. The guide provides information to the Proponent on key terrestrial and marine habitat areas that are essential to the welfare of various migratory bird species in Canada.

9. For further information on how to protect migratory birds, their nests and eggs when planning or carrying out project activities, consult Environment and Climate Change Canada's Incidental Take web page and the fact sheet "Planning Ahead to Reduce the Risk of Detrimental Effects to Migratory Birds, and their Nests and Eggs" available at http://www.ec.gc.ca/paom-itmb/.

**Transport of Dangerous Goods and Waste Management**

10. Environment and Climate Change Canada recommends that all hazardous wastes, including waste oil, receive proper treatment and disposal at an approved facility.

11. The Proponent shall ensure that proper shipping documents (waste manifests, transportation of dangerous goods, etc.) accompany all movements of dangerous goods. Further, the

Proponent shall ensure that the shipment of all dangerous goods is registered with the Government of Nunavut Department of Environment, Department of Environment Manager. Contact the Manager (867) 975-7748 to obtain a manifest if dangerous goods including hazardous wastes will be transported.

## REGULATORY REQUIREMENTS

***The Board previously recommended in the May 30, 2012 and September 22, 2015 Screening Decision Report(s) for the "Eureka Weather Station Facility" project the following legislation, which continues to apply to the current proposal:***

**Acts and Regulations**

1. The *Fisheries Act* (http://laws-lois.justice.gc.ca/eng/acts/F-14/index.html).

2. The *Nunavut Waters and Nunavut Surface Rights Tribunal Act* (http://www.canlii.org/ca/sta/n-28.8/whole.html).

3. The *Migratory Birds Convention Act* and *Migratory Birds Regulations* (http://laws-lois.justice.gc.ca/eng/acts/M-7.01/).

4. The *Species at Risk Act* (http://laws-lois.justice.gc.ca/eng/acts/S-15.3/index.html). Attached in **Appendix B** is a list of Species at Risk in Nunavut.

5. The *Wildlife Act* (http://www.canlii.org/en/nu/laws/stat/snu-2003-c-26/latest/snu-2003-c-26.html) which contains provisions to protect and conserve wildlife and wildlife habitat, including specific protection measures for wildlife habitat and species at risk.

6. The *Nunavut Act* (http://laws-lois.justice.gc.ca/eng/acts/N-28.6/). The Proponent must comply with the proposed terms and conditions listed in the attached **Appendix C**.

7. (*updated*) The *Transportation of Dangerous Goods Regulations* (http://www.tc.gc.ca/eng/tdg/clear-tofc-211.htm), *Transportation of Dangerous Goods Act* (http://laws-lois.justice.gc.ca/eng/acts/t-19.01/), and the *Canadian Environmental Protection Act* (http://laws-lois.justice.gc.ca/eng/acts/C-15.31/).

8. The *Aeronautics Act* (http://laws-lois.justice.gc.ca/eng/acts/A-2/ /).

**Other Applicable Guidelines**

9. The *Federal Guidelines for Landfarming Petroleum Hydrocarbon Contaminated Soils,* Science Applications International Corporation (SAIC Canada), March, 2006. Information in this document addresses design, operation, monitoring, sampling, analytical methods, decommissioning and closure, record keeping and reporting requirements for landfarming projects. It is recommended that the consultant refer to this document as it relates to the future operations of the landfarming project.

10. (*updated*) The *Northern Land Use Guidelines Pits and Quarries* (http://www.aadnc-aandc.gc.ca/eng/1100100023585) provide guidelines for progressive reclamation applicable to establishment of pits and quarries.

***In addition, the Proponent is also advised that the following legislation may apply to the project:***

**Acts and Regulations**

11. The Proponent shall undertake quarrying in accordance with the *Nunavut Mining Safety Ordinance* and the *Territorial Quarrying Regulations* (http://www.canlii.org/en/ca/laws/regu/crc-c-1527/latest/crc-c-1527.html) or equivalent.

## CONCLUSION

The foregoing constitutes the Board's screening decision with respect to the Environment and Climate Change Canada's "Amended Land Use Permit application for Eureka Weather Station". The NIRB remains available for consultation with the Minister regarding this report as necessary.

Dated: June 1, 2018 at Whale Cove, NU.

Elizabeth Copland, Chairperson

Attachments: Appendix A: Previously-Screened Project Proposals
Appendix B: Species at Risk in Nunavut
Appendix C: Archaeological and Palaeontological Resources Terms and Conditions for Land Use Permit Holders

## APPENDIX A: PREVIOUSLY-SCREENED PROJECT PROPOSALS

The original project proposal NIRB (File No. 12XN020), was received by the NIRB from the Nunavut Planning Commission and Aboriginal Affairs and Northern Development Canada on April 19, 2012 and was screened by the Board in accordance with Part 4, Article 12 of the *Agreement between the Inuit of the Nunavut Settlement Area and Her Majesty the Queen in right of Canada* (*Nunavut Agreement*). On May 30, 2012 the NIRB issued a *Nunavut Agreement* 12.4.4(a) screening decision to the then Minister of Aboriginal Affairs and Northern Development (now Minister of Crown-Indigenous Relations and Northern Affairs) which indicated that the proposed project could proceed subject to the NIRB's recommended project-specific terms and conditions.

Environment Canada's (now Environment and Climate Change Canada or Proponent) original "Eureka Weather Station Facility" project was located in the Qikiqtani (North Baffin) region, approximately 407 kilometres (km) northwest of Grise Fiord on Crown Land Reserve #1021. The Eureka Weather Station Facility was originally established in 1947 with additional building added in subsequent years and a Research Support Opportunity established in 1987. The primary purpose of the facilities was to collect meteorological information. The secondary purpose was to provide logistical support and a staging location for science based research, exploration and military operations as well as serve the small tourist trade that visits the area. At the time of the 2012 application, the Eureka station was to be used by both the Department of National Defence and the Natural Resources Canada (NRCan) Polar Continental Shelf program. Operations were to continue year round at the various facilities that are now in place.

According to the previously screened project proposal, the scope of the project included the following undertakings, works or activities:

- Operations and maintenance of all of the existing Eureka infrastructure, specifically:
    - Airstrip and all access roads,
    - Tankfarm and fuel supply system,
    - Water and sewage lagoons,
    - Heating and electricity,
    - Biotreatment cell (landfarm),
    - Disposal/burning of non-hazardous landfill,
    - Hazardous materials collected and barged off site to be disposed of appropriately, and
    - Accommodations, laboratories, and general storage and warehousing.
- Ongoing use of the Eureka as a base camp and logistical support/staging areas for other entities/organizations such as the Department of National Defence and NRCan's Polar Continental Shelf Program.

Additional authorization and extension requests associated with the "Eureka Weather Station Facility" project have also been reviewed by the NIRB following screening of the original project proposal (File No. 12XN020). In each instance where the NIRB received applications up to and including December 18, 2014, the NIRB confirmed that the applications were exempt from the requirement for further screening pursuant to Section 12.4.3 of the *Nunavut Agreement* and that the activities therein remained subject to the terms and conditions recommended in the

original May 30, 2012 Screening Decision Report. On September 22, 2015, after receiving an application for additional activities, the NIRB issued additional terms and conditions associated with the "Eureka Weather Station Facility" project as per 12.4.4(a) of the *Nunavut Agreement*.

The following is a summary of the previously screened project activities as received by the NIRB:

1) The scope associated with the previous December 18, 2014 extension request included continued operations of the facility for previously approved activities.

2) The scope associated with the previous June 29, 2015 amendment application included:
   - Upgrading infrastructure at the Eureka site between August 2015 and September 2017;
   - Construction of a new airside apron and rehabilitation of existing airstrip, airside apron and access road at the Eureka Weather Station Facility; and
   - Removal of up to 160,900 cubic metres of aggregate from the existing Blacktop Creek Quarry.

## Appendix B
Species at Risk in Nunavut

Due to the requirements of Section 79(2) of the Species At Risk Act (SARA), and the potential for project-specific adverse effects on listed wildlife species and its critical habitat, measures should be taken as appropriate to avoid or lessen those effects, and the effects need to be monitored. Project effects could include species disturbance, attraction to operations and destruction of habitat. This section applies to all species listed on Schedule 1 of SARA, as listed in the table below, or have been assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), which may be encountered in the project area. This list may not include all species identified as at risk by the Territorial Government. The following points provide clarification on the applicability of the species outlined in the table.

- Schedule 1 is the official legal list of Species at Risk for SARA. SARA applies to all species on Schedule 1. The term "listed" species refers to species on Schedule 1.
- Schedule 2 and 3 of SARA identify species that were designated at risk by the COSEWIC prior to October 1999 and must be reassessed using revised criteria before they can be considered for addition to Schedule 1.
- Some species identified at risk by COSEWIC are "pending" addition to Schedule 1 of SARA. These species are under consideration for addition to Schedule 1, subject to further consultation or assessment.

If species at risk are encountered or affected, the primary mitigation measure should be avoidance. The Proponent should avoid contact with or disturbance to each species, its habitat and/or its residence. All direct, indirect, and cumulative effects should be considered. Refer to species status reports and other information on the species at risk Registry at http://www.sararegistry.gc.ca for information on specific species.

Monitoring should be undertaken by the Proponent to determine the effectiveness of mitigation and/or identify where further mitigation is required. As a minimum, this monitoring should include recording the locations and dates of any observations of species at risk, behaviour or actions taken by the animals when project activities were encountered, and any actions taken by the proponent to avoid contact or disturbance to the species, its habitat, and/or its residence. This information should be submitted to the appropriate regulators and organizations with management responsibility for that species, as requested.

For species primarily managed by the Territorial Government, the Territorial Government should be consulted to identify other appropriate mitigation and/or monitoring measures to minimize effects to these species from the project.

Mitigation and monitoring measures must be undertaken in a way that is consistent with applicable recovery strategies and action/management plans.

Schedules of SARA are amended on a regular basis so it is important to check the SARA registry (www.sararegistry.gc.ca) to get the current status of a species.

Updated: September 2017

| Terrestrial Species at Risk [1] | COSEWIC Designation | Schedule of SARA | Government Organization with Primary Management Responsibility [2] |
|---|---|---|---|
| Migratory Birds | | | |
| Buff-breasted Sandpiper | Special concern | Schedule 1 | ECCC |
| Eskimo Curlew | Endangered | Schedule 1 | ECCC |
| Harlequin Duck (Eastern population) | Special Concern | Schedule 1 | ECCC |
| Harris's Sparrow | Special Concern | Pending | ECCC |
| Horned Grebe (Western population) | Special Concern | Schedule 1 | ECCC |
| Ivory Gull | Endangered | Schedule 1 | ECCC |
| Peregrine Falcon | Special Concern (*anatum-tundrius* complex[3]) | Schedule 1 - Schedule 3 | ECCC |
| Red Knot (*islandica* subspecies) | Special Concern | Schedule 1 | ECCC |
| Red Knot (*rufa* subspecies) | Endangered | Schedule 1 | ECCC |
| Red-necked Phalarope | Special concern | Pending | ECCC |
| Ross's Gull | Threatened | Schedule 1 | ECCC |
| Rusty Blackbird | Special Concern | Schedule 1 | ECCC |
| Short-eared Owl | Special Concern | Schedule 1 | ECCC |
| Vegetation | | | |
| Blanket-leaved Willow | Special Concern | Schedule 1 | Government of Nunavut |
| Felt-leaf Willow | Special Concern | Schedule 1 | Government of Nunavut |
| Porsild's Bryum (Moss) | Threatened | Schedule 1 | Government of Nunavut |
| Arthropods | | | |
| Traverse Lady Beetle | Special Concern | Pending | Government of Nunavut |
| Terrestrial Wildlife | | | |
| Caribou (Barren-Ground population) | Threatened | Pending | Government of Nunavut |
| Dolphin and Union Caribou | Special Concern | Schedule 1 | Government of Nunavut |
| Grizzly Bear (Western Population) | Special Concern | Pending | Government of Nunavut |
| Peary Caribou | Endangered | Schedule 1 | Government of Nunavut |
| Peary Caribou (High Arctic Population) | Endangered | Schedule 2 | Government of Nunavut |
| Peary Caribou (Low Arctic Population) | Threatened | Schedule 2 | Government of Nunavut |
| Wolverine | Special Concern | Pending | Government of Nunavut |
| Wolverine (Western population) | Non-active | Pending | Government of Nunavut |
| Marine Wildlife | | | |
| Atlantic Walrus | Special Concern | Pending | DFO |
| Beluga Whale (Cumberland Sound population) | Endangered | Schedule 2 | DFO |
| Beluga Whale (Eastern High Arctic – Baffin Bay population) | Special Concern | Pending | DFO |
| Beluga Whale (Eastern Hudson Bay population) | Endangered | Pending | DFO |

| | | | |
|---|---|---|---|
| Beluga Whale (Southeast Baffin Island – Cumberland Sound population) | Endangered | Schedule 2 | DFO |
| Beluga Whale (Western Hudson Bay population) | Special Concern | Pending | DFO |
| Bowhead Whale (Eastern Arctic population | Endangered | Schedule 2 | DFO |
| Bowhead Whale (Eastern Canada – West Greenland population) | Special Concern | Pending | DFO |
| Killer Whale (Northwest Atlantic / Eastern Arctic populations) | Special Concern | Pending | DFO |
| Narwhal | Special Concern | Pending | DFO |
| Polar Bear | Special Concern | Schedule 1 | Government of Nunavut/DFO |
| Fish | | | |
| Atlantic Cod, Arctic Lakes | Special Concern | Pending | DFO |
| Atlantic Wolffish | Special Concern | Schedule 1 | DFO |
| Bering Wolffish | Special Concern | Schedule 3 | DFO |
| Blackline Prickleback | Special Concern | Schedule 3 | DFO |
| Fourhorn Sculpin | Special Concern | Schedule 3 | DFO |
| Fourhorn Sculpin (Freshwater form) | Data Deficient | Schedule 3 | DFO |
| Northern Wolffish | Threatened | Schedule 1 | DFO |
| Roundnose Grenadier | Endangered | Pending | DFO |
| Spotted Whitefish | Threatened | Schedule 1 | DFO |
| Thorny Skate | Special Concern | Pending | DFO |

[1] The Department of Fisheries and Oceans has responsibility for aquatic species.

[2] Environment Canada (EC) has a national role to play in the conservation and recovery of Species at Risk in Canada, as well as responsibility for management of birds described in the Migratory Birds Convention Act (MBCA). Day-to-day management of terrestrial species not covered in the MBCA is the responsibility of the Territorial Government. Populations that exist in National Parks are also managed under the authority of the Parks Canada Agency.

## Appendix C
## Archaeological and Palaeontological Resources Terms and Conditions for Land Use Permit Holders

### INTRODUCTION

The Department of Culture and Heritage (CH) routinely reviews land use applications sent to the Nunavut Water Board, Nunavut Impact Review Board and the Indigenous and Northern Affairs Canada. These terms and conditions provide general direction to the permittee/proponent regarding the appropriate actions to be taken to ensure the permittee/proponent carries out its role in the protection of Nunavut's archaeological and palaeontological resources.

### TERMS AND CONDITIONS

1) The permittee/proponent shall have a professional archaeologist and/or palaeontologist perform the following **Functions** associated with the **Types of Development** listed below or similar development activities:

| | **Types of Development** (See Guidelines below) | **Function** (See Guidelines below) |
|---|---|---|
| a) | Large scale prospecting | Archaeological/Palaeontological Overview Assessment |
| b) | Diamond drilling for exploration or geotechnical purpose or planning of linear disturbances | Archaeological/ Palaeontological Inventory |
| c) | Construction of linear disturbances, Extractive disturbances, Impounding disturbances and other land disturbance activities | Archaeological/ Palaeontological Inventory or Assessment or Mitigation |

Note that the above-mentioned functions require either a Nunavut Archaeologist Permit or a Nunavut Palaeontologist Permit. CH is authorized by way of the *Nunavut and Archaeological and Palaeontological Site Regulations*[1] to issue such permits.

2) The permittee/proponent shall not operate any vehicle over a known or suspected archaeological or palaeontological site.

[1] P.C. 2001-1111 14 June, 2001

3) The permittee/proponent shall not remove, disturb, or displace any archaeological artifact or site, or any fossil or palaeontological site.

4) The permittee/proponent shall immediately contact CH at (867) 934-2046 or (867) 975-5500 should an archaeological site or specimen, or a palaeontological site or fossil, be encountered or disturbed by any land use activity.

5) The permittee/proponent shall immediately cease any activity that disturbs an archaeological or palaeontological site encountered during the course of a land use operation until permitted to proceed with the authorization of CH.

6) The permittee/proponent shall follow the direction of CH in restoring disturbed archaeological or palaeontological sites to an acceptable condition. If these conditions are attached to either a Class A or B Permit under the Territorial Lands Act Indigenous and Northern Affairs Canada directions will also be followed.

7) The permittee/proponent shall provide all information requested by CH concerning all archaeological sites or artifacts and all palaeontological sites and fossils encountered in the course of any land use activity.

8) The permittee/proponent shall make best efforts to ensure that all persons working under its authority are aware of these conditions concerning archaeological sites and artifacts and palaeontological sites and fossils.

9) If a list of recorded archaeological and/or palaeontological sites is provided to the permittee/proponent by CH as part of the review of the land use application the permittee/proponent shall avoid the archaeological and/or palaeontological sites listed.

10) Should a list of recorded sites be provided to the permittee/proponent, the information is provided solely for the purpose of the proponent's land use activities as described in the land use application, and must otherwise be treated confidentially by the proponent.

## Legal Framework

As stated in Article 33 of the *Agreement between the Inuit of the Nunavut Settlement Area and Her Majesty the Queen in right of Canada* (*Nunavut Agreement*):

*Where an application is made for a land use permit in the Nunavut Settlement Area, and there are reasonable grounds to believe that there could be sites of archaeological importance on the lands affected, no land use permit shall be issued without written consent of the Designated Agency. Such consent shall not be unreasonably withheld. [33.5.12]*

*Each land use permit referred to in Section 33.5.12 shall specify the plans and methods of archeological site protection and restoration to be followed by the permit holder, and any other conditions the Designated Agency may deem fit. [33.5.13]*

**Palaeontology and Archaeology**

Under the *Nunavut Act*[2], the federal government can make regulations for the protection, care and preservation of palaeontological and archaeological sites and specimens in Nunavut. Under

[2] s. 51(1)

the *Nunavut Archaeological and Palaeontological Sites Regulations*[3], it is illegal to alter or disturb any palaeontological or archaeological site in Nunavut unless permission is first granted through the permitting process.

**Definitions**
As defined in the *Nunavut Archaeological and Palaeontological Sites Regulations*, the following definitions apply:

> *"archaeological site" means a place where an archaeological artifact is found.*
>
> *"archaeological artifact" means any tangible evidence of human activity that is more than 50 years old and in respect of which an unbroken chain of possession or regular pattern of usage cannot be demonstrated, and includes a Denesuline archaeological specimen referred to in section 40.4.9 of the Agreement between the Inuit of the Nunavut Settlement Area and Her Majesty the Queen in right of Canada (Nunavut Agreement).*
>
> *"palaeontological site" means a site where a fossil is found.*
>
> *"fossil" includes:*
> *Fossil means the hardened or preserved remains or impression of previously living organisms or vegetation and includes:*
> *(a) natural casts;*
> *(b) preserved tracks, coprolites and plant remains; and*
> *(c) the preserved shells and exoskeletons of invertebrates and the preserved eggs, teeth and bones of vertebrates.*

*Guidelines for Developers for the Protection of Archaeological Resources in the Nunavut Territory*

(**Note:** Partial document only, complete document at: www.ch.gov.nu.ca/en/Archaeology.aspx)

**Introduction**
The following guidelines have been formulated to ensure that the impacts of proposed developments upon heritage resources are assessed and mitigated before ground surface altering activities occur. Heritage resources are defined as, but not limited to, archaeological and historical sites, burial grounds, palaeontological sites, historic buildings and cairns Effective collaboration between the developer, the Department of Culture, and Heritage (CH), and the contract archaeologist(s) will ensure proper preservation of heritage resources in the Nunavut Territory. The roles of each are briefly described.

CH is the Nunavut Government agency which oversees the protection and management of heritage resources in Nunavut, in partnership with land claim authorities, regulatory agencies, and the federal government. Its role in mitigating impacts of developments on heritage resources is as follows: to identify the need for an impact assessment and make recommendations to the appropriate regulatory agency; set the terms of reference for the study depending upon the scope of the development; suggest the names of qualified individuals

[3] P.C. 2001-1111 14 June, 2001

prepared to undertake the study to the developer; issue an archaeologist or palaeontologist permit authorizing field work; assess the completeness of the study and its recommendations; and ensure that the developer complies with the recommendations.

The primary regulatory agencies that CH provides information and assistance to are the Nunavut Impact Review Board, for development activities proposed for Inuit Owned Lands (as defined in Section 1.1.1 of the *Agreement between the Inuit of the Nunavut Settlement Area and Her Majesty the Queen in right of Canada* (*Nunavut Agreement*)), and the Indigenous and Northern Affairs Canada, for development activities proposed for federal Crown Lands.

A developer is the initiator of a land use activity. It is the obligation of the developer to ensure that a qualified archaeologist or palaeontologist is hired to perform the required study and that provisions of the contract with the archaeologist or palaeontologist allow permit requirements to be met; i.e. fieldwork, collections management, artifact and specimen conservation, and report preparation. On the recommendation of the contract archaeologist or palaeontologist in the field and the Government of Nunavut, the developer shall implement avoidance or mitigative measures to protect heritage resources or to salvage the information they contain through excavation, analysis, and report writing. The developer assumes all costs associated with the study in its entirety.

Through his or her active participation and supervision of the study, the contract archaeologist or palaeontologist is accountable for the quality of work undertaken and the quality of the report produced. Facilities to conduct fieldwork, analysis, and report preparation should be available to this individual through institutional, agency, or company affiliations. Responsibility for the curation of objects recovered during field work while under study and for documents generated in the course of the study as well as remittance of artifacts, specimens and documents to the repository specified on the permit accrue to the contract archaeologist or palaeontologist. This individual is also bound by the legal requirements of the *Nunavut Archaeological and Palaeontological Sites Regulations*.

**Types of Development**

In general, those developments that cause concern for the safety of heritage resources will include one or more of the following kinds of surface disturbances. These categories, in combination, are comprehensive of the major kinds of developments commonly proposed in Nunavut. For any single development proposal, several kinds of these disturbances may be involved

- *Linear disturbances: including the construction of highways, roads, winter roads, transmission lines, and pipelines;*
- *Extractive disturbances: including mining, gravel removal, quarrying, and land filling;*
- *Impoundment disturbances: including dams, reservoirs, and tailings ponds;*
- *Intensive land use disturbances: including industrial, residential, commercial, recreational, and land reclamation work, and use of heritage resources as tourist developments.*

- *Mineral, oil and gas exploration: establishment of camps, temporary airstrips, access routes, well sites, or quarries all have potential for impacting heritage resources*.

**Types of Studies Undertaken to Preserve Heritage Resources**

**Overview:** An overview study of heritage resources should be conducted at the same time as the development project is being designed or its feasibility addressed. They usually lack specificity with regard to the exact location(s) and form(s) of impact and involve limited, if any, field surveys. Their main aim is to accumulate, evaluate, and synthesize the existing knowledge of the heritage of the known area of impact. The overview study provides managers with baseline data from which recommendations for future research and forecasts of potential impacts can be made. A Class I Permit is required for this type of study if field surveys are undertaken.

**Reconnaissance:** This is done to provide a judgmental appraisal of a region sufficient to provide the developer, the consultant, and government managers with recommendations for further development planning. This study may be implemented as a preliminary step to inventory and assessment investigations except in cases where a reconnaissance may indicate a very low or negligible heritage resource potential. Alternately, in the case of small-scale or linear developments, an inventory study may be recommended and obviate the need for a reconnaissance.

The main goal of a reconnaissance study is to provide baseline data for the verification of the presence of potential heritage resources, the determination of impacts to these resources, the generation of terms of reference for further studies and, if required, the advancement of preliminary mitigative and compensatory plans. The results of reconnaissance studies are primarily useful for the selection of alternatives and secondarily as a means of identifying impacts that must be mitigated after the final siting and design of the development project. Depending on the scope of the study, a Class 1 or Class 2 Permit is required for this type of investigation.

**Inventory:** A resource inventory is generally conducted at that stage in a project's development at which the geographical area(s) likely to sustain direct, indirect, and perceived impacts can be well defined. This requires systematic and intensive fieldwork to ascertain the effects of all possible and alternate construction components on heritage resources. All heritage sites must be recorded on Government of Nunavut Site Survey forms. Sufficient information must be amassed from field, library and archival components of the study to generate a predictive model of the heritage resource base that will:

- allow the identification of research and conservation opportunities;
- enable the developer to make planning decisions and recognize their likely effects on the known or predicted resources; and
- make the developer aware of the expenditures, which may be required for subsequent studies and mitigation. A Class 1 or 2 permit is required.

**Assessment:** At this stage, sufficient information concerning the numbers and locations of heritage resources will be available, as well as data to predict the forms and magnitude of impacts. Assessments provide information on the size, volume, complexity and content of a

heritage resource, which is used to rank the values of different sites or site types given current archaeological knowledge. As this information will shape subsequent mitigation program(s), great care is necessary during this phase.

**Mitigation:** This refers to the amelioration of adverse impacts to heritage resources and involves the avoidance of impact through the redesign or relocation of a development or its components; the protection of the resource by constructing physical facilities; or, the scientific investigation and recovery of information from the resource by excavation or other method. The type(s) of appropriate mitigative measures are dictated by their viability in the context of the development project. Mitigation strategies must be developed in consultation with, and approved by, the Department of Culture and Heritage. It is important to note that mitigation activities should be initiated as far in advance of the construction of the development as possible.

**Surveillance and monitoring:** These may be required as part of the mitigation program.

*Surveillance* may be conducted during the construction phase of a project to ensure that the developer has complied with the recommendations.

*Monitoring* involves identification and inspection of residual and long-term impacts of a development (i.e. shoreline stability of a reservoir); or the use of impacts to disclose the presence of heritage resources, for example, the uncovering of buried sites during the construction of a pipeline.

**From:** Wajmer, Nicole <Nicole.Wajmer@dfo-mpo.gc.ca>
**Sent:** Tuesday, February 20, 2018 8:53 AM
**To:** dominic.matte@canada.ca
**Cc:** Laura Barz
**Subject:** 18-HCAA-00071, Bridge Construction, Small Creek near Slidre Fiord, Eureka High Arctic Weather Station

**Subject: Serious Harm to Fish and Prohibited Effects on Listed Aquatic Species at Risk Can Be Avoided or Mitigated - 18-HCAA-00071, Bridge Construction, Small Creek near Slidre Fiord, Eureka High Arctic Weather Station**

Dear Dominic Matte:

The Fisheries Protection Program (the Program) of Fisheries and Oceans Canada (DFO) received your proposal on January 29, 2018. We understand that you propose to:

Construct a temporary bridge over Black Top Creek in June 2018;

Construct a permanent bridge and four culverts over Black Top Creek in August 2018.

Our review considered the following information:

Request for Review form and associated documents;

Email correspondence with Laura Barz on February 19, 2018;

Drawings of proposed project.

Construct a permanent bridge and four culverts over Black Top Creek in August 2018Your proposal has been reviewed to determine whether it is likely to result in serious harm to fish which is prohibited under subsection 35(1) of the *Fisheries Act* unless authorized. Your proposal has also been reviewed to determine whether it is likely to affect listed aquatic species at risk, any part of their critical habitat or the residences of their individuals in a manner which is prohibited under sections 32, 33 and subsection 58(1) of the *Species at Risk Act*, unless authorized.

Provided that your plans are implemented in the manner, and during the timeframe, described, the Program has determined that your proposal will not result in serious harm to fish or prohibited effects on listed aquatic species at risk. As such, an authorization under the *Fisheries Act* or a permit under the *Species at Risk Act* is not required.

Should your plans change or if you have omitted some information in your proposal, further review by the Program may be required. Consult our website (http://www.dfo-mpo.gc.ca/pnw-ppe/index-eng.html) or consult with a qualified environmental consultant to determine if further review may be necessary. It remains your responsibility to avoid causing serious harm to fish in compliance with the *Fisheries Act*, and avoid prohibited effects on listed aquatic species at risk, any part of their critical habitat or the residences of their individuals in compliance with the *Species at Risk Act*.

It is also your *Duty to Notify* DFO if you have caused, or are about to cause, serious harm to fish that are part of or support a commercial, recreational or Aboriginal fishery. Such notifications should be directed to http://www.dfo-mpo.gc.ca/pnw-ppe/violation-infraction/index-eng.html.

A copy of this letter should be kept on site while the work is in progress. It remains your responsibility to meet all other federal, territorial, provincial and municipal requirements that apply to your proposal.

If you have any questions with the content of this letter, please contact our Burlington office by email at fisheriesprotection@dfo-mpo.gc.ca. Please refer to the file number referenced above when corresponding with the Program.

Yours sincerely,

Nicole Wajmer
Fisheries Protection Biologist
Fisheries and Oceans Canada

Fisheries and Oceans Canada | Pêches et Océans Canada

Ontario and Prairie Region
Fish and Fish Habitat Protection Program
867 Lakeshore Road
Burlington, Ontario
L7S 1A1

Région de l'Ontario et des Prairies
Programme de protection du poisson et de son habitat
867 chemin Lakeshore
Burlington, Ontario
L7S 1A1

March 24, 2021

*Your file* *Votre référence*

*Our file* *Notre référence*

21-HCAA-00295

Jean-Phillipe Cloutier-Dussault
Environment and Climate Change Canada
160, chemin du Tour-de-l'Isle
Montreal, Quebec H3C 4G8

**Subject: Temporary Culverts, Remus Creek, Baffin Region (21-HCAA-00295) – Implementation of Measures to Avoid and Mitigate the Potential for Prohibited Effects to Fish and Fish Habitat**

Dear Jean-Phillipe Cloutier-Dussault:

The Fish and Fish Habitat Protection Program (the Program) of Fisheries and Oceans Canada (DFO) received your proposal on January 22, 2021. We understand that you propose to:

- Install up to three (3) temporary culverts of maximum size 0.6x12m on each of two watercourse crossings on Remus Creek and West Remus Creek to allow construction access to the High Arctic Weather Station until October 2025 (total maximum footprint = 140m$^2$);
- Minimally grade the channel, as necessary for culvert installation.
- Isolate work area from flowing water to prevent sedementation of the watercourse.

Our review considered the following information:

- Request for Review form and supporting information submitted by Robin Reese, AECOM, via email on January 22, 2021.
- Additional information submitted by Robin Reese, AECOM, via email on March 18, 2021.

Your proposal has been reviewed to determine whether it is likely to result in:

- the death of fish by means other than fishing and the harmful alteration, disruption or destruction of fish habitat which are prohibited under subsections 34.4(1) and 35(1) of the *Fisheries Act*; and,
- effects to listed aquatic species at risk, any part of their critical habitat or the residences of their individuals in a manner which is prohibited under sections 32, 33 and subsection 58(1) of the *Species at Risk Act*.

The aforementioned impacts are prohibited unless authorized under their respective legislation and regulations.

To avoid and mitigate the potential for prohibited effects to fish and fish habitat (as listed above), we recommend implementing the measures listed below:

- Conduct in-water undertakings and activities during periods of low flow;
- Limit the duration of in-water works, undertakings and activities so that it does not diminish the ability of fish to carry out one or more of their life processes (spawning, rearing, feeding, migrating);
- Restore stream geomorphology (i.e., restore the bed and banks, gradient and contour of the waterbody) to its initial state;
- Replace/restore any other disturbed habitat features and remediate any areas impacted by the work, undertaking or activity;
- Develop and implement a Sediment Control Plan to minimize sedimentation of the waterbody during all phases of the work, undertaking or activity;
    - Conduct all in-water works, undertakings or activities in isolation of open or flowing water to reduce the introduction of sediment into the watercourse;
    - Schedule work to avoid wet, windy and rainy periods (and heed weather advisories);
    - Operate machinery on land in stable dry areas;
    - Monitor the watercourse to observe signs of sedimentation during all phases of the work, undertaking or activity and take corrective action;
    - Dispose and stabilize all dredged material above the high water mark of nearby waterbodies to prevent entry in the water;
- Develop and implement a response plan to avoid a spill of deleterious substances.

Provided that you incorporate these measures into your plans, the Program is of the view that your proposal will not require an authorization the *Fisheries Act*, the *Aquatic Invasive Species Regulations* or the *Species at Risk Act*.

Should your plans change or if you have omitted some information in your proposal, further review by the Program may be required. Consult our website (http://www.dfo-mpo.gc.ca/pnw-ppe/index-eng.html) or consult with a qualified environmental consultant to determine if further review may be necessary. It remains your responsibility to remain in compliance with the *Fisheries Act*, avoid prohibited effects on listed aquatic species at risk, any part of their critical habitat or the residences of their individuals, and prevent the introduction of non-indigenous species.

It is also your *Duty to Notify* DFO if you have caused, or are about to cause, the death of fish by means other than fishing and/or the harmful alteration, disruption or destruction of fish habitat. Such notifications should be directed to FisheriesProtection@dfo-mpo.gc.ca or 1-855-852-8320.

Please notify this office at least 10 days before starting your project. A copy of this letter should be kept on site while the work is in progress. It remains your responsibility to meet all other federal, territorial, provincial and municipal requirements that apply to your proposal.

If you have any questions with the content of this letter, please contact Deborah Silver at our Burlington office at 365-323-0247 or deborah.silver@dfo-mpo.gc.ca. Please refer to the file number referenced above when corresponding with the Program.

Yours sincerely,

Deborah Silver
Biologist, Triage and Planning
Fish and Fish Habitat Protection Program

CC:
Robin Reese, AECOM, robin.reese@aecom.com
Laura MacKay, Public Services & Procurement Canada, Laura.MacKay@pwgsc-tpsgc.gc.ca

# APPENDIX B: EUREKA TEMPORARY CLOSURE SOPs & CHECKLIST

| | Standard Operating Procedure | Page: 1 of 4 |
|---|---|---|
| Environment Canada | Version: 1 | Date: Dec. 1, 2010 |
| Location: Eureka | Title: Building Temporary Closure | Prepared by Carl Carroll |

## 1. Purpose

To ensure that this component of the Eureka site does not become a source of contamination or a safety hazard to wildlife and humans during temporary closure periods.

## 2. Scope

To notify all relevant stakeholders of the anticipated temporary building closures as well as to give instruction to site personnel for the proper procedures to be undertaken when it is required to temporarily close buildings at the Eureka Facility. These procedures are to include the external and internal building systems, related to all buildings, which need to be addressed in order to close said buildings and maintain an adequate loss control program until such time as the buildings can be reopened for resumed operations.

## 3. Authority

The authority for issuing the Temporary building closure will be held by the Station Program Manager (SPM). The intentions of such closure are to be communicated in advance, to all relevant stakeholders including ECCC personnel, DND personnel, CANDAC personnel, Nunavut Water Board personnel, Airport Authority personnel, all research organizations occupying Eureka facilities, and all relevant Public Company personnel that use or intend to use the Eureka Facilities.

## 4. Requirements

Environment Canada will ensure that the following general conditions are met:

- Sufficient staff are on-site to protect the health and safety of humans, wildlife and the environment and the expertise is made available to care for the site and any potential problems that may arise;
- Sufficient and proper equipment and supplies are left on site for any maintenance or reclamation activities that may need to be implemented;
- Access to the site, buildings and other structures will be secured and restricted to authorized personnel only;
- Warning signs continue to be posted where appropriate

# 5. Procedures

## 5.1 *Building Exterior*

- Clear roof and wall vents.
- Check the roof for possible damages and repair as necessary.
- Review building additions or new roof equipment that may increase snow drifting during winter months. Areas where snowdrifts are likely to occur include: intersections of low and high roofs; valleys between two peaked roofs; and intersections of roof and roof-mounted equipment. Excessive snowdrifts increase the weight applied to roof structures and may cause collapse.
- Check roof flashings for leaks.
- Check all roof equipment (exhaust and intake fans/vents, antennas, signs, etc.) mounts are secure against damage during heavy winds.
- Check that all windows are properly closed, sealed, and locked.
- Check all building openings to ensure they are weather-tight so that they will not admit cold air that could cause building systems to freeze or allow entry routes for pests.
- Verify the proper functioning of all exterior lighting
- Check the remaining portions of the exterior of the building, securing anything that could blow around in high winds and cause damage.
- Upon completion of temporary building closure procedures, verify that all buildings are secured and locked.

## *5.2 Building Interior*

### *5.2.1 General*

- Maintain an indoor temperature above 5ºC for currently heated buildings
- Ensure circulation of indoor air is sufficient to maintain adequate temperatures near outer walls
- Remove and safely dispose of unnecessary combustible refuse material
- Remove flammable residues from work areas (ie. Hoods, ducts, ovens, floors, etc.)
- Have all flammable liquids and products properly sealed and stored in appropriate flammable storage cabinets
- Ensure passageways are clear of obstacles and/or debris
- Ensure there is an 18 inch clear space between sprinklers and structural members and storage materials where applicable (pay particular attention in storage areas)

- Ensure that fire doors are unblocked and operating freely
- Remove accumulated dust from overhead piping, machinery etc. where necessary in order to minimize fire hazards

### *5.2.2 Heating Equipment*

- Inspect heating coils, unit heater, air-handling units, and space heaters for proper operation (see EOC Mechanical Preventative Maintenance Packages for details)
- Store combustibles safely away from heating equipment
- Inspect and test safety shutoff valves and cut-off switches on combustion equipment
- Ensure there is an adequate supply of fuel for heating equipment. Fill up above ground storage tanks when/where necessary.
- Inspect heat generation equipment (ie. Generators, stand-by boiler etc.), heat transfer systems, pumps, piping (external Utilidor and internal building), and related safety controls for proper operation (see EOC Mechanical Preventative Maintenance Packages for details)

### *5.2.3 Mechanical Equipment*

- For water cooled equipment, provide adequate heat, locate in heated enclosure, or provide the proper antifreeze solution
- Remove low points and dead ends from piping where possible; other-wise elevate low points and provide drain valves
- Drain all unnecessary pipes and toilets. S-traps and toilet bowl can be filled with plumber's antifreeze to prevent possible freezing.
- Check pressure vessel vents, relief valves, and safety valves to assure that moving parts are protected from water accumulation or freezing of vapour.
- If water is to be shut off to a particular building, shut off the switch to the pump, drain water from all the faucets and from the pump itself, turn off any hot water heater(s) and drain tanks.
- Provide heat tracing and insulation on water-filled instrumentation and control lines, and inspect this equipment.
- Drain and close all exposed water pipes and valves that would be susceptible to freezing.
- Inspect all Water Tanks and supporting equipment for proper operation and absence of leakages. (See PM work package M15100A for specific details)
- Hydraulic power equipment (ie. vehicle lifts etc.) are to be cleaned, drained of oil, and locked out as required

### *5.2.4 Electrical Equipment*

- Ensure lights are clear of combustible materials
- Ensure that all temporary wiring has been removed
- Disconnect and lock-out all unnecessary circuits at main switchboards
- Ensure power is available for emergency systems
- Ensure that unnecessary transformers have been de-energized
- Ensure that dirt and grease have been cleaned from equipment that is necessary to remain operating

### *5.2.5 Life Safety Equipment*

- Inspect and maintain all fire suppression and life safety systems in proper operating order (see Life Safety Systems preventative maintenance packages for details)
- For sprinklered buildings where heat will or cannot be maintained at or above 5ºC;
    - Close all affected sprinkler valves and all fire-pump water valves
    - Drain fire-pump motor jacket(s), sprinklers, domestic water pipes, instrument pipes, boilers, toilet water closets, heaters, and coolers
    - Close domestic water valves and water valve to equipment lines
    - Heat trace (with electric wire) pipes that cannot be drained
    - As soon as sufficient building heat is restored, reactivate fire protection systems
- Check that portable fire extinguishers located in areas subject to freezing are suitable for such locations.
- Drain all fixed eyewash stations and store all portable stations accordingly

### *5.2.6 Special Equipment*

- Verify that proper storage for equipment requiring special protection such as computers, micro-processors, delicate electronics, etc., have been provided
- Verify that all unnecessary mobile equipment for facilities support has been locked and stored appropriately (drain fuel tanks, remove batteries, secure ignition keys, etc.)

## 5.3 Monitoring

- Implement a regular monitoring program that includes the visual inspection of all exterior and interior building areas for items requiring attention and are to include

but not limited to;

- Ensure the building exits are not impeded and the doors are operating properly
- The entryways are clear of ice/debris and are safe (no tripping hazards).
- That the building is secure, no doors open and left unattended
- That security lights are working - yard and building fixtures
- That the building hallways are not impeded and that there are no tripping hazards.
- That there are no obvious building items that pose a hazard i.e. light lenses loose, ceiling tiles loose, broken electrical switches or receptacles, broken glass/windows, etc.
- Verification of alarm panel and life safety systems to ensure no trouble alarms have been activated

> All findings and observations noted during these monitoring rounds will be assessed and the appropriate group/individual will be contacted for appropriate action if necessary. Actions taken to address deficiencies are to be noted in a log book. Pages are to be consecutively numbered, and the date shown at the top of the page. Pages are not to be removed, and pages are not to include more than one day's activity.

## Approval

Name, Title of Authority date

Name, Title of Authority date

Name, Title of Authority date

| | Standard Operating Procedure | Page: 1 of 3 |
|---|---|---|
| Environment Canada | Version: 1 | Date: Dec. 1, 2010 |
| Location: Eureka | Title: Lagoon and Earthen Manure Storage Structures Temporary Closure | Prepared by Carl Carroll |

## 6. Purpose

To ensure that this component of the Eureka site does not become a source of contamination or a safety hazard to wildlife and humans during temporary closure periods.

## 7. Scope

To notify all relevant stakeholders of the anticipated temporary Lagoon and Earthen Manure Storage Structure closures as well as to give instruction to site personnel for the proper procedures to be undertaken when it is required to temporarily close such structures at the Eureka Facility. These procedures are to include the necessary measures required to be undertaken to temporarily close said structures and maintain an adequate monitoring program until such time as the structures can be re-opened for resumed operations.

## 8. Authority

The authority for issuing the temporary closure will be held by the Station Program Manager (SPM). The intentions of such closure are to be communicated in advance, to all relevant stakeholders including Environment Canada personnel, DND personnel, CANDAC personnel, Nunavut Water Board personnel, Airport Authority personnel, all research organizations occupying Eureka facilities, and all relevant Public Company personnel that use or intend to use the Eureka Facilities.

## 9. Requirements

Environment Canada will ensure that the following general conditions are met:

- Sufficient staff are on-site to protect the health and safety of humans, wildlife and the environment and the expertise is made available to care for the site and any potential problems that may arise;
- Sufficient and proper equipment and supplies are left on site for any maintenance or reclamation activities that may need to be implemented;
- Access to the site, buildings and other structures will be secured and restricted to authorized personnel only;
- Warning signs continue to be posted where appropriate

# 10. Procedures

## 10.1 *Initial inspections*

- Identify all possible source of runoff that may be directed toward the lagoon.
- Inspect lagoon containment wall conditions and identify possible weak points where seepage could possibly occur
- Identify all possible entry points to lagoons
- Sample and analyze contents of lagoons to use as baseline indicator
- Identify current lagoon levels and amount of freeboard
- Record all findings

## *5.2 Closure Period*

### *5.2.1 Summer closure period (when lagoons may be discharged and/or refilled)*

- Divert possible surface water runoff away from lagoons where necessary.
- Erect and Maintain fences and post warning signs around lagoons and uncovered structures
- Reinforce containment structure walls with the addition of soil and/or compaction with heavy machinery where necessary
- For the Sewage lagoon;
    - perform yearly drainage and testing of effluent according to yearly procedures outlined in the SUMMARY OF OPERATIONS AND MAINTENANCE PROCEDURES FOR DRINKING WATER, SEWAGE, SOLID WASTE DISPOSAL AND WASTE TREATMENT FACILITIES
    - Monitor and maintain the appropriate freeboard levels for the sewage lagoon.
- For the Water Lagoon;
    - Pump water from lagoon in order to fill the domestic water holding tanks to ensure availability of water required upon re-opening of facilities.
    - Refill water lagoon to capacity as per the procedures outlined in the SUMMARY OF OPERATIONS AND MAINTENANCE PROCEDURES FOR DRINKING WATER, SEWAGE, SOLID WASTE DISPOSAL AND WASTE TREATMENT FACILITIES.
    - Monitor and maintain the appropriate freeboard levels for the Water Lagoon

- Repair where necessary, and maintain, all pumping and piping infrastructure related to Lagoons

### *5.2.2 Other Than Summer Closure Period (no discharge/refill possible)*

- Divert possible surface water runoff away from lagoons where necessary.
- Erect and Maintain fences and post warning signs around lagoons and uncovered structures
- Reinforce containment structure walls with the addition of soil and/or compaction with heavy machinery where necessary (if not already frozen)
- Monitor and maintain the appropriate freeboard levels for the Lagoons
- Maintain water source opening at Water Lagoon to ensure access to water upon re-opening of facility
- Repair where necessary, and maintain, all pumping and piping infrastructure related to Lagoons

## 6. Monitoring

Implement a regular monitoring program that includes the visual inspection of all lagoon areas, surface water runoff areas, and drainage areas that may require attention.

This monitoring program can be included with that of other Temporary Closure SOPs if these closures occur simultaneously.

As a general rule, all findings and observations noted during these monitoring rounds will be assessed and the appropriate group/individual will be contacted for appropriate action if necessary. Actions taken to address deficiencies are to be noted in a log book. Pages are to be consecutively numbered, and the date shown at the top of the page. Pages are not to be removed, and pages are not to include more than one day's activity.

## Approval

Name, Title of Authority date

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| | Standard Operating Procedure | Page: 1 of 3 |
|---|---|---|
| Environment Canada | Version: 1 | Date: Dec. 1, 2010 |
| Location: Eureka | Title: Contaminated Sites Temporary Closure | Prepared by Carl Carroll |

## 11. Purpose

To ensure that this component of the Eureka site does not become a source of contamination or a safety hazard to wildlife and humans during temporary closure periods.

## 12. Scope

To notify all relevant stakeholders of the anticipated temporary closure of the contaminated sites area as well as to give instruction to site personnel for the proper procedures to be undertaken when it is required to temporarily close this area at the Eureka Facility.

## 13. Authority

The authority for issuing the temporary closure will be held by the Station Program Manager (SPM). The intentions of such closure are to be communicated in advance, to all relevant stakeholders including Environment Canada personnel, DND personnel, CANDAC personnel, Nunavut Water Board personnel, Airport Authority personnel, all research organizations occupying Eureka facilities, and all relevant Public Company personnel that use or intend to use the Eureka Facilities.

## 14. Requirements

Environment Canada will ensure that the following general conditions are met:

- Sufficient staff are on-site to protect the health and safety of humans, wildlife and the environment and the expertise is made available to care for the site and any potential problems that may arise;
- Sufficient and proper equipment and supplies are left on site for any maintenance or reclamation activities that may need to be implemented;
- Access to the site, buildings and other structures will be secured and restricted to authorized personnel only;
- Warning signs continue to be posted where appropriate

# 15. Procedures

## 15.1 *Initial inspections*

- Identify all possible source of runoff that may be directed toward and/or away from the contaminated site areas.
- Inspect contaminated site areas perimeter fencing and warning signs, where applicable, for needed repairs.
- Identify all possible entry points to the contaminated site areas and cordon off where applicable.
- Identify, sample and analyze any leachate to use as baseline indicator
- Identify current conditions, photograph and record all findings

## *5.2 Temporary Closure Period*

- Divert possible surface water runoff away from contaminated site areas where necessary.
- Erect and Maintain fences and post warning signs around contaminated site areas wherever possible
- Provide weighted cover materials for monitoring pits/wells surrounding contaminated site areas
- Where possible, apply additional layer of soil in order to cap contaminated surface soil in order to protect wildlife from contact exposure

# 6. Monitoring

- Implement a regular monitoring program that includes the visual inspection of all contaminated site areas and related confinement infrastructure, surface water runoff areas, and drainage ditches that may require attention.
- For extended periods of temporary closure, it may be necessary to resample, analyse, and record groundwater and/or surface water, where applicable, in order to identify any changes in function of the established confinement and control measure for the contaminated site areas.
- As a general rule, all findings and observations noted during these monitoring rounds will be assessed and the appropriate group/individual will be contacted for appropriate action if necessary. Actions taken to address deficiencies are to be noted in a log book. Pages are to be consecutively numbered, and the date shown at the top of the page. Pages are not to be removed, and pages are not to include more than one day's activity.

## Approval

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| Name, Title of Authority | date |
| Name, Title of Authority | date |
| Name, Title of Authority | date |

| | Standard Operating Procedure | Page: 1 of 4 |
|---|---|---|
| Environment Canada | Version: 1 | Date: Dec. 1, 2010 |
| Location: Eureka | Title: Facility Infrastructure Temporary Closure | Prepared by Carl Carroll |

## 16. Purpose

To ensure that this component of the Eureka site does not become a source of contamination or a safety hazard to wildlife and humans during temporary closure periods.

## 17. Scope

To notify all relevant stakeholders of the anticipated temporary closure at the Eureka Facility and to give instruction to site personnel for the proper procedures to be undertaken for the temporary closure of the related infrastructure until such time as the facility re-opens for operations.

## 18. Authority

The authority for issuing the temporary closure will be held by the Station Program Manager (SPM). The intentions of such closure are to be communicated in advance, to all relevant stakeholders including Environment Canada personnel, DND personnel, CANDAC personnel, Nunavut Water Board personnel, Airport Authority personnel, all research organizations occupying Eureka facilities, and all relevant Public Company personnel that use or intend to use the Eureka Facilities.

## 19. Requirements

Environment Canada will ensure that the following general conditions are met:

- Sufficient staff are on-site to protect the health and safety of humans, wildlife and the environment and the expertise is made available to care for the site and any potential problems that may arise;
- Sufficient and proper equipment and supplies are left on site for any maintenance or reclamation activities that may need to be implemented;
- Access to the site, buildings and other structures will be secured and restricted to authorized personnel only;
- Warning signs continue to be posted where appropriate

# 20. Procedures

## 20.1 *Pre-closure*

- Identify all non-essential infrastructure that requires temporary shutdown due to changes in operating conditions or circumstances
- Maintain all essential infrastructure in order to support remaining on-site staff required during the temporary closure period

## *5.2 Temporary Closure Period*

### *5.2.1 Essential Roads*

- Perform regularly scheduled surface reshaping or repair
- Perform regularly scheduled ditch and culvert cleaning, repair
- Perform regular snow thaw road check and repair when necessary
- Perform storm damage and pollution control structure check and repair
- Perform seasonal check of signs and notices

### *5.2.2 Non-Essential Roads*

- Pre and post thaw season channel crossing and ditch maintenance prior to closure when applicable
- Storm damage and pollution control structure check and repair prior to temporary closure when applicable
- Perform surface reshaping or repair as necessary prior to temporary closure when applicable
- Periodic check of closure controls and signs where applicable prior to and during temporary closure period where applicable

### *5.2.3 Airstrip*

- Perform surface reshaping or repair as necessary prior to closure
- Perform regular snow thaw checks and repair when necessary prior to closure
- Final inspection of runway lighting and correction of deficiencies when/where necessary prior to temporary closure
- De-energize power supply to runway lighting when not in use (other than essential or emergency use in support of on-site personnel during temporary closure period)

- Periodic check of closure controls and signs where applicable prior to and during temporary closure period when/where applicable

### *5.2.4 Electrical Power Supply*

- Maintain essential power supply systems during temporary closure period (generators, essential electrical distribution lines, life safety systems, fuel pumping supply systems, Utilidor and heat transfer systems, etc)
- De-energize non-essential power supply systems and related transformers

### *5.2.5 Heat Transfer Systems*

- Maintain essential heat transfer system (powerhouse) and utilidor supply to essential buildings during temporary closure period
- Shut off supply of heat supply piping to non-essential buildings, when/where applicable,

  during temporary closure period

### *5.2.6 Water Supply and Distribution System*

- Maintain potable water distribution system in support of on-site staff during temporary closure period
- Maintain waste distribution system in support of on-site staff during temporary closure period

### *5.2.7 Barge landing area*

- Storm damage and pollution control structure check and repair prior to temporary closure when applicable (ensure fuel transfer spill receptacle at shore pipeline connection is covered and secured)
- Perform surface reshaping or repair as necessary prior to temporary closure where applicable
- Periodic check of closure controls and signs where applicable prior to and during temporary closure period where applicable

### *5.2.8 Fuel Delivery systems*

- Shut down fuel delivery systems/piping to non-essential buildings when/where

  applicable during temporary closure period
- Maintain fuel delivery systems to essential buildings and infrastructure that support on-site staff during temporary closure period
- Perform regularly scheduled inspections/verifications of the fuel tank farm, related fuel delivery piping & systems, and above ground storage tanks as per operations guidelines

# 6. Monitoring

- Implement a regular monitoring program that includes the visual inspection of the essential and non-essential infrastructure systems for integrity as well as the fuel delivery systems
- Report any spills immediately to the Nunavut Report line at (867) 920-8130
- As a general rule, all findings and observations noted during these monitoring rounds will be assessed and the appropriate group/individual will be contacted for appropriate action if necessary. Actions taken to address deficiencies are to be noted in a log book. Pages are to be consecutively numbered, and the date shown at the top of the page. Pages are not to be removed, and pages are not to include more than one day's activity.

## Approval

Name, Title of Authority date

Name, Title of Authority date

Name, Title of Authority date

| | Standard Operating Procedure | Page: 1 of 3 |
|---|---|---|
| Environment Canada | Version: 1 | Date: Dec. 1, 2010 |
| Location: Eureka | Title: Temporary Storage Plan for Hazardous Materials | Prepared by Carl Carroll |

## 21. Purpose

To ensure that this component of the Eureka site does not become a source of contamination or a safety hazard to wildlife and humans during temporary closure periods.

## 22. Scope

To notify all relevant stakeholders of the anticipated temporary closure at the Eureka Facility and to give instruction to site personnel for the proper procedures to be undertaken for the temporary storage of hazardous materials until such time as the facility re-opens for operations.

## 23. Authority

The authority for issuing the temporary closure will be held by the Station Program Manager (SPM). The intentions of such closure are to be communicated in advance, to all relevant stakeholders including Environment Canada personnel, DND personnel, CANDAC personnel, Nunavut Water Board personnel, Airport Authority personnel, all research organizations occupying Eureka facilities, and all relevant Public Company personnel that use or intend to use the Eureka Facilities.

## 24. Requirements

Environment Canada will ensure that the following general conditions are met:

- Sufficient staff are on-site to protect the health and safety of humans, wildlife and the environment and the expertise is made available to care for the site and any potential problems that may arise;
- Sufficient and proper equipment and supplies are left on site for any maintenance or reclamation activities that may need to be implemented;
- Access to the site, buildings and other structures will be secured and restricted to authorized personnel only;
- Warning signs continue to be posted where appropriate

# 25. Procedures

## 25.1 *Initial inspections*

- Identify all possible sources and current site storage locations of hazardous materials including but not limited to small compounds near the tank farm, surrounding the DND warehouse, garages, and the Hydrogen Building.
- Identify possible locations to safely and centrally locate various types/classifications of hazardous materials for temporary storage
- Identify any requirements necessary to secure access to hazardous materials (lock buildings, storage cabinets, fence off outdoor areas etc.)

## *5.2 Temporary Closure Period*

- When possible, package and ship off site any used and unwanted hazardous materials to appropriate disposal sites in order to reduce on site hazardous material inventory during temporary closure periods
- Ensure that all hazardous materials as sealed and stored in appropriate containers designed for such purposes
- Ensure the storage of hazardous materials according to the following guidelines:
    - Compatibility of wastes is respected (do not store together)
        - Acids & cyanides
        - Flammable/combustibles and oxidizers
        - Strong acids & strong alkalies
        - Acids & water
        - Solvents & corrosives
        - Flammable liquids & ignition sources
    - Segregation – wastes should be segregated based on final disposal options
    - Ventilation – Highly volatile organic hazards can present serious health risk. Waste should be stored outside in sheds which provide free air movement.
    - Climate/Environment – consideration must be given to freezing temperatures and precipitation when storing wastes.
- Erect and Maintain fences, where necessary, and post warning signs around outdoor hazardous material storage areas.
- Provide the appropriate WHMIS documentation at the storage site locations
- Provide the appropriate secondary containment and spill response kits for storage areas

> Ensure appropriate fire prevention measures are in place for the storage areas > Ensure leak detection programs are in place for storage tanks

> Ensure chemical transport and storage procedures meet compliance standards outlined in the Canada Labour Code, Canadian Environmental Protection Act, National Building Code, National Fire Code of Canada, Transportation of Dangerous Goods Act, and The Government of Nunavut Environmental Protection Act, Territorial and Lands Act, and all other applicable statutes, regulations, standards, guidelines, and local by-laws.

## 6. Monitoring

- Implement a regular monitoring program that includes the visual inspection of the hazardous material storage areas and storage tank locations
- Report any spills immediately to the Nunavut Report line at

  (867) 920-8130
- As a general rule, all findings and observations noted during these monitoring rounds will be assessed and the appropriate group/individual will be contacted for appropriate action if necessary. Actions taken to address deficiencies are to be noted in a log book. Pages are to be consecutively numbered, and the date shown at the top of the page. Pages are not to be removed, and pages are not to include more than one day's activity.

Approval

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Name, Title of Authority date

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Name, Title of Authority date

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Name, Title of Authority date

| | Standard Operating Procedure | Page: 1 of 3 |
|---|---|---|
| Environment Canada | Version: 1 | Date: Dec. 1, 2010 |
| Location: Eureka | Title: Solid Waste Landfill Site Temporary Closure | Prepared by Carl Carroll |

## 26. Purpose

To ensure that this component of the Eureka site does not become a source of contamination or a safety hazard to wildlife and humans during temporary closure periods.

## 27. Scope

To notify all relevant stakeholders of the anticipated temporary closure of the solid waste landfill sites areas as well as to give instruction to site personnel for the proper procedures to be undertaken when it is required to temporarily close this area at the Eureka Facility.

## 28. Authority

The authority for issuing the temporary closure will be held by the Station Program Manager (SPM) . The intentions of such closure are to be communicated in advance, to all relevant stakeholders including Environment Canada personnel, DND personnel, CANDAC personnel, Nunavut Water Board personnel, Airport Authority personnel, all research organizations occupying Eureka facilities, and all relevant Public Company personnel that use or intend to use the Eureka Facilities.

## 29. Requirements

Environment Canada will ensure that the following general conditions are met:

- Sufficient staff are on-site to protect the health and safety of humans, wildlife and the environment and the expertise is made available to care for the site and any potential problems that may arise;
- Sufficient and proper equipment and supplies are left on site for any maintenance or reclamation activities that may need to be implemented;
- Access to the site, buildings and other structures will be secured and restricted to authorized personnel only;
- Warning signs continue to be posted where appropriate

## 30. Procedures

### 30.1 *Initial inspections*

- Identify all possible source of runoff that may be directed toward and/or away from the solid waste landfill site areas.
- Inspect solid waste landfill site areas and perimeter to identify capping requirements
- Identify all monitoring wells/pits for the solid waste landfill areas.
- Identify, sample and analyze leachate, if any, to use as baseline indicator
- Identify current conditions, photograph and record all findings

### *5.2 Temporary Closure Period*

- Divert possible surface water runoff away from solid waste landfill site areas where necessary.
- Erect and Maintain fences and post warning signs around solid waste landfill monitoring wells/pits where applicable
- Provide weighted cover materials for monitoring pits/wells surrounding contaminated site areas
- Where possible, apply additional layer of soil in order to adequately cap solid waste landfill areas in order to protect wildlife from contact exposure and/or windblown debris

## 6. Monitoring

- Implement a regular monitoring program that includes the visual inspection of the solid waste landfill areas and related confinement infrastructure for monitoring wells/pits, surface water runoff areas, and drainage ditches that may require attention.
- For extended periods of temporary closure, it may be necessary to resample, analyse, and record groundwater and/or surface water, where applicable, in order to identify any changes in function of the established confinement and control measure for the solid waste landfill site areas.
- As a general rule, all findings and observations noted during these monitoring rounds will be assessed and the appropriate group/individual will be contacted for appropriate action if necessary. Actions taken to address deficiencies are to be noted in a log book. Pages are to be consecutively numbered, and the date shown at the top of the page. Pages are not to be removed, and pages are not to include more than one day's activity.

## Approval

Name, Title of Authority date

Name, Title of Authority date

Name, Title of Authority date

| | Standard Operating Procedure | Page: 1 of 3 |
|---|---|---|
| Environment Canada | Version: 1 | Date: Dec. 1, 2010 |
| Location: Eureka | Title: Incinerator Temporary Closure | Prepared by Carl Carroll |

## 31. Purpose

To ensure that this component of the Eureka site does not become a source of contamination or a safety hazard to wildlife and humans during temporary closure periods.

## 32. Scope

To notify all relevant stakeholders of the anticipated temporary closure at the Eureka Facility and to give instruction to site personnel for the proper procedures to be undertaken for the temporary closure of the incinerator until such time as the facility re-opens for operations.

## 33. Authority

The authority for issuing the temporary closure will be held by the Station Program Manager (SPM). The intentions of such closure are to be communicated in advance, to all relevant stakeholders including Environment Canada personnel, DND personnel, CANDAC personnel, Nunavut Water Board personnel, Airport Authority personnel, all research organizations occupying Eureka facilities, and all relevant Public Company personnel that use or intend to use the Eureka Facilities.

## 34. Requirements

Environment Canada will ensure that the following general conditions are met:

- Sufficient staff are on-site to protect the health and safety of humans, wildlife and the environment and the expertise is made available to care for the site and any potential problems that may arise;
- Sufficient and proper equipment and supplies are left on site for any maintenance or reclamation activities that may need to be implemented;
- Access to the site, buildings and other structures will be secured and restricted to authorized personnel only;
- Warning signs continue to be posted where appropriate

# 35. Procedures

## 35.1 *Pre-closure*

- Identify and collect all possible sources of organic non-hazardous waste materials that require incineration prior to facility temporary closure.
- Incinerate all remaining wastes
- Allow the incinerator to cool sufficiently (approximately 6-8 hours) and dispose of ash accordingly

## *5.2 Temporary Closure Period*

- Perform Routine incinerator shutdown inspection and maintenance including:
  - Lock out and tag out power to equipment as required
  - Check fuel lines for leaks and check connections
  - Close both fuel line shutoff valves (near tank and near burner)
  - Drain lines, inspect and change filter if necessary
  - Check spark arrestor to ensure no plugging
  - Inspect refractory for large cracks (not expansion cracks)
  - Check combustion air hole for plugging
  - Inspect door gaskets for damages
  - Inspect condition of chimney
- If applicable (pending timing of temporary closure with yearly maintenance crew arrival), have annual service performed by professional Technician as indicated in Westland Environmental Services Inc. Operations and Maintenance manual. (see burner section page 13)
- Disconnect and lock out power to incinerator
- Perform general interior cleaning of building as required
- Secure incinerator and ensure access is available only to authorized personnel for periodical monitoring

# 6. Monitoring

- Implement a regular monitoring program that includes the visual inspection of the interior and exterior of the incinerator building envelope for integrity as well as the associated above ground fuel storage tank and fuel lines.
- Report any spills immediately to the Nunavut Report line at

  (867) 920-8130
- As a general rule, all findings and observations noted during these monitoring rounds will be assessed and the appropriate group/individual will be contacted for appropriate action if necessary. Actions taken to address deficiencies are to be noted in a log book. Pages are to be consecutively numbered, and the date shown at the top of the page. Pages are not to be removed, and pages are not to include more than one day's activity.

## Approval

Name, Title of Authority date

Name, Title of Authority date

Name, Title of Authority date

# Monthly Temporary Closure Inspection Checklist

Property Management Division, District 3, Eureka

Facility: _____

Month: Inspected by:

> READ CHECKLIST BEFORE > ALWAYS TAKE PICTURES > REPAIR AND DOCUMENT

VISUAL INSPECTION

OF THE DAMAGES OR THE ISSUE

| | Y or N | Comments |
|---|---|---|
| **Building Conditions** | | |
| Is the interior of the buildings in good order? Verify building hallways are not impeded and that there are no obvious building items that pose a hazard or are in need or repairs (check piping and critical systems in all areas) Ensure alarm panel and life safety systems & security lights are working properly etc. | ☐ Yes ☐ No | |
| Is the exterior of the buildings in good order? Verify building entrance areas are not impeded, exterior doors are operating properly, and that there are no obvious building items that pose a hazard or are in need or repairs. Ensure exterior security lights are working etc. | ☐ Yes ☐ No | |
| Has building been secured upon completion of inspection (door entrances locked, window coverings still in place, etc) ? | ☐ Yes ☐ No | |
| **Lagoon Conditions** | | |
| Is there any evidence of damage to or seepage from lagoon walls, record freeboard levels? (runoff diverted away from lagoons?) | ☐ Yes ☐ No Freeboard | |

| | | |
|---|---|---|
| Is the area clear of debris, fencing in good condition, is signage in place? | ☐ Yes ☐ No | |
| **Contaminated Site Conditions** | | |
| Is runoff diverted away from contaminated sites? Is the area secured? (check that area is clear of debris, fencing is in good condition, signage in place) | ☐ Yes ☐ No | |
| Are all monitoring wells and pits covered and secured? | ☐ Yes ☐ No | |
| Are drainage areas and ditches free of runoff and/or leachate? (If leachate present, photograph area, resample and have analyzed, record results) | ☐ Yes ☐ No | |
| **Facility Infrastructure Conditions** | | |
| Are essential roads, ditches, and signage in satisfactory condition? (clear & grade roads as required, clear ditches) | ☐ Yes ☐ No | |
| Are non-essential roads, ditches, and signage in satisfactory condition? (verify that signage is still in place, note non-essential road deficiencies do be addressed upon re-opening of operations) | ☐ Yes ☐ No | |
| Is the Airstrip and runway lighting in good condition? (clear & grade as required in event runway is temporarily required, turn on runway lighting and check for deficient lights & replace) | ☐ Yes ☐ No | |
| Is the power supply and distribution system in good condition? (Perform inspections of generators, fuel supply, and related distribution systems) | ☐ Yes ☐ No | |
| Is the heat supply and distribution system in good condition? (Inspect generators, heat exchangers, pumps, related piping) | ☐ Yes ☐ No | |

| | | |
|---|---|---|
| Is the water supply and distribution system in good condition? (Inspect water lagoon intake, storage tanks, filtration/chlorination/U.V. systems, and related external building and internal building related piping) | ☐ Yes ☐ No | |
| Has weekly and monthly fuel supply and transfer systems been performed? | ☐ Yes ☐ No | |
| **Solid Waste Landfill Conditions** | | |
| Is runoff diverted away from landfill areas? Is the area secured and well capped? (check that area is clear of debris, fencing is in good condition, signage in place) | ☐ Yes ☐ No | |
| Are all monitoring wells and pits covered and secured? | ☐ Yes ☐ No | |
| Are drainage areas and ditches free of runoff and/or leachate? (If leachate present, photograph area, resample and have analyzed, record results) | ☐ Yes ☐ No | |
| **Hazardous Materials Storage Areas** | | |
| Are hazardous material storage areas in good conditions? (visual inspection for leaks, unusual odors, damage containers etc) | ☐ Yes ☐ No | |
| Are spill kits, personal protective equipment, and WHMIS documentation easily accessible and fully stocked? | ☐ Yes ☐ No | |
| **Incinerator Building** | | |
| Is the Incinerator in good condition? (Verify interior for fuel leaks, interior/exterior envelope for integrity, entrances are cleared, exterior fuel supply/piping free of leaks etc.) | ☐ Yes ☐ No | |

# APPENDIX C: Hydrogen Generator Technical Manual

TM 18-10-01

Environment Canada | Environnement Canada

Atmospheric Environment Service | Service de l'environnement atmosphérique

# TECHNICAL MANUAL

# 5-CELL ELECTROLYTIC HYDROGEN GENERATOR (MODEL M20-AES)

The equipment described in this publication has been approved for use in Atmospheric Environment Service observational networks by the Director-General, Central Services Directorate

Originated under the authority of the Director of the Data Acquisition Systems Branch

Canada

27 September 1986

Environment Canada
Atmospheric Environment Service

Environnement Canada
Service de l'environnement atmosphérique

# TECHNICAL MANUAL

# 5-CELL ELECTROLYTIC HYDROGEN GENERATOR (MODEL M20-AES)

The equipment described in this publication has been approved for use in Atmospheric Environment Service observational networks by the Director-General Atmospheric Monitoring and Water Survey Directorate

Originated under the authority of the Director-General Atmospheric Monitoring and Water Survey Directorate

U.D.C. 551.824

27 September 1986

Change 3 - 26 July 1999

Available from

Atmospheric Environment Service
Atmospheric Monitoring and Water Survey Directorate
National Monitoring and Operations Division
4905 Dufferin Street
Downsview (Ontario)
M3H 5T4

**U.D.C. 551.824**

# LIST OF EFFECTIVE PAGES

This page lists the status of all pages in this manual. Pages of the original issue are identified by a zero in the Change No. column. Pages which have subsequently changed are identified by the change number. On a changed page, the text affected by the latest change is indicated by a vertical bar. Added or completely revised sections, paragraphs, tables, illustrations, etc. are indicated by a vertical bar.

| | |
|---|---|
| Original | 27 September 1986 |
| Change 1 | 20 October 1989 |
| Change 2 | 23 December 1992 |
| Change 3 | 16 July 1999 |

Total number of printed sides in this manual is 164, as listed below.

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| xiv and xv | 1 | 5-11 | 0 |
| xvi and xvii/(xviii Blank) | 0 | 5-12 | 2 |
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| 1-4 to 1-5 | 0 | 5-14 | 0 |
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| 2-3 to 2-8 | 3 | 5-18 to 5-33 | 0 |
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| 2-10 | 1 | 5-35 to 5-36 | 0 |
| 2-11 to 2-20 | 0 | 5-37/5-38 | 2 |
| 3-1/(3-2 Blank) | 0 | 5-39 to 5-40 | 0 |
| 4-1 to 4-4 | 0 | 5-41 to 5-45 | 1 |
| 4-5 to 4-6 | 3 | 5-46 to 5-47/(5-48 Blank) | 0 |
| 4-7 | 0 | 6-1 | 1 |
| 4-8 | 2 | 6-2 to 6-4 | 0 |
| 4-9 | 1 | 6-5 | 2 |
| 4-10 to 4-13 | 0 | 6-6 | 0 |
| 4-14 | 1 | 6-7 to 6-10 | 1 |
| 4-15 TO 4-17 | 0 | 6-11/(6-12 Blank) | 2 |
| 4-18 | 2 | 6-13/(6-14 Blank) | 0 |
| 4-19 | 2 | 6-15/(6-16 Blank) | 2 |
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# LIST OF EFFECTIVE PAGES

This page lists the status of all pages in this manual. Pages of the original issue are identified by a zero in the Change No. column. Pages which have subsequently changed are identified by the change number. On a changed page, the text affected by the latest change is indicated by a vertical bar. Added or completely revised sections, paragraphs, tables, illustrations, etc. are indicated by a vertical bar.

| | |
|---|---|
| Original | 27 September 1986 |
| Change 1 | 20 October 1989 |
| Change 2 | 23 December 1992 |
| Change 3 | 16 July 1999 |

Total number of printed sides in this manual is 164, as listed below.

| PAGE | REVISION NO. | PAGE | REVISION NO. |
|---|---|---|---|
| 6-27/(6-28 Blank) | 0 | | |
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| Improvement Pages | 0 | | |

# RECORD OF CHANGES

Retain this record in the front of the manual. On receipt of changes; insert changed pages, remove deleted and replaced pages, enter the change number, change date, and insertion date on this record and initial the entry.

| CHANGE NO. | CHANGE DATE | INSERTION DATE | BY |
|---|---|---|---|
| 1 | Oct. 20/89 | Nov. 89 | JBP |
| 2 | Dec. 23/92 | Jan 22/93 | gt |
| 3 | 99-07-26 | 00-05-21 | AHB |
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# MODIFICATION INSTRUCTION LIST

List all Modification Instruction sheets that are applicable to the subject equipment, or that contain instructions that affect the instructions in this manual. When the contents of any Modification Instruction sheet has been formally incorporated into this manual, the originating authority will complete the Incorporated at Change No. column and reissue this list.

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# INFORMATION BULLETIN LIST

List all Information Bulletins that are applicable to the subject equipment, or that contain instructions that affect the instructions in this manual. When the contents of any Information Bulletin has been formally incorporated into this manual, the originating authority will complete the Incorporated at Change No. column and reissue this list.

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LIST OF TABLES

## LIST OF ILLUSTRATIONS

# PREFACE

The text in this manual is formulated to comply with the guidelines on metrication.

In most instances, the dimensions and sizes of hardware and its application are expressed in the units of original design to avoid conflict with the known and approved technical and procurement specifications and drawings.

Where applicable, converted values are written in brackets and usually represent rounded-off values.

* * * * * *

Notes, cautions and warnings are used and illustrated in this manual as follows:

NOTE

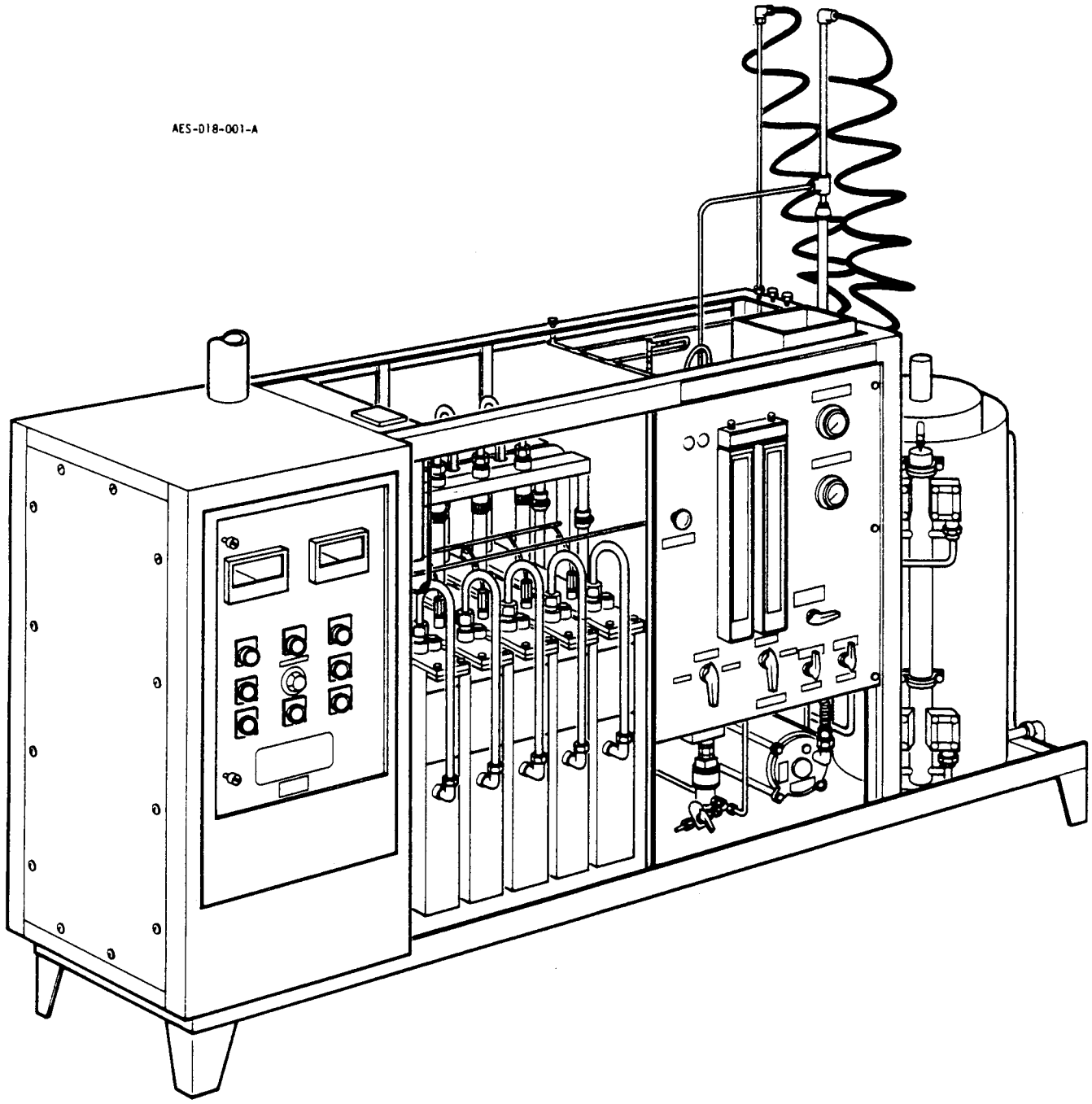
A note is an operating or maintenance procedure, condition, statement, etc., which it is essential to highlight.

**CAUTION**

A caution is an operating or maintenance procedure, practice, condition, statement, etc., which if not strictly observed could result in damage to, or destruction of, equipment.

**WARNING**

A warning is an operating or maintenance procedure, practise, condition, statement, etc., which if not strictly observed could result in injury to, or death of personnel.

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# SECTION 1

# GENERAL INFORMATION

## PURPOSE AND SCOPE OF MANUAL

1.1 This manual describes the operational and maintenance requirements and procedures for the Electrolytic Hydrogen Generator Model M20-AES. Included in the description of the system is the Control/Alarm Panel and the CD800W Gas Detector System.

## BACKGROUND INFORMATION

1.2 There are thirty Aerological Stations in the AES Network which utilize the Electrolytic Hydrogen Generator for gas production. The gas is used to fill balloons which carry aloft Radiosonde instruments. The instruments measure and transmit meteorological data to ground stations.

1.2.1 Hydrogen is used because it can be produced at the stations. Its main disadvantage is that it is highly flammable and can be explosive. Strict safety practices must be observed to reduce the risk of fire or explosion.

1.2.2 The equipment and all safety devices must be maintained in good working order at all times.

## THE HYDROGEN GENERATOR SYSTEM

1.3 The Hydrogen Generating System is made up of the following sub-systems:

(a) The Control/Alarm Panel and Light/Bell Assembly

(b) The Gas Detection/Alarm System

(c) The Fire Detection System

(d) The Electrolytic Hydrogen Generator

(e) The Storage Tank and Inflation System

## GENERAL SYSTEM DESCRIPTION

1.4 The Control Alarm Unit is used to supply or disrupt the flow of power to the Electrolytic Hydrogen Generator. When the Control/Alarm Panel is energized, its main contact closes and 240 volts are supplied to the electrical cubicle of the Electrolytic Hydrogen Generator. Four safety devices when activated will open the main contact and cut off the power supply to the generator:

(a) The 'EMERGENCY OFF' button S5 on the electrical cubicle door.

(b) The Fire Detector above the Electrolytic Hydrogen Generator or in the Electrical Room when temperature exceeds 60°C.

(c) The Gas Detector when an abnormally high concentration of hydrogen is present.

(d) The Low Pressure switch 'S10' when pressure in the low pressure line drops below one inch watercolumn.

1.4.1 Two lights and an alarm bell are mounted outside the hydrogen building and are wired into the Control Alarm Panel. They are triggered when any of the four safety devices are activated.

1.4.2 The 240 volt a.c. power supply from the Control/Alarm Panel connects into the electrical cubicle of the generator. A rectifier converts the a.c. supply to direct current and this is fed to the cells. The cells are filled with an electrolyte solution into which two electrodes are immersed. When current flows through the electrodes and the solution, electrolysis takes place causing hydrogen and oxygen to be released. The oxygen is released into the atmosphere. The hydrogen is routed from the cells through a water seal into a low pressure gasholder at a rate of 20 cu. ft. (.57 $m^3$) per hour. A compressor pumps the gas from the gasholder into a storage tank. A balloon filling line with a flow control valve goes into the inflation room. A hose connects this line to a filling stand where the balloon inflation takes place.

1.4.3 Numerous electro-mechanical safety devices throughout the system ensure that abnormal conditions result in plant shutdown.

## SAFETY

1.5 Because of the inherent danger of hydrogen, numerous safety devices have been incorporated into the system to protect the operator by reducing all risks to the lowest level possible. All building and electrical codes must be strictly observed and extreme caution must be exercised when working on or around the equipment. The staff should be familiar with safety practices and know which procedures to follow in case of an emergency.

1.5.1 PROPERTIES OF HYDROGEN Hydrogen is a colourless, odorless and tasteless gas. It is extremely flammable when mixed with air in the range from 4% to 74% by volume. Within this range, ignition of hydrogen/air mixture can occur with extremely low energy input such as a static discharge. The actual flame of a hydrogen fire is colourless and becomes visible only when in presence of other burning material such as paint.

1.5.2 PREVENTION OF HYDROGEN FIRES There are two basic rules for preventing or reducing the risk of hydrogen fire or explosion:

(a) Prevent an explosive mixture from forming, and

(b) Eliminate all sources of ignition.

1.5.2.1 Preventing An Explosive Mixture This is accomplished by eliminating all sources of impure and uncontained hydrogen. The generating room should be well ventilated and the ceiling vent at least partially open at all times. The wall vent should be checked regularly for blockage.

1.5.2.1.1 All operational and maintenance procedures should be followed to ensure that the equipment is operating properly. Inflated balloons should not be left in the building any longer than necessary.

1.5.2.1.2 If a hole is discovered in an inflated balloon, the balloon should be removed outside and allowed to deflate. In built-up areas where a floating balloon would be a hazard, the balloon should be tethered until it becomes deflated.

1.5.2.1.3 The hydrogen generating equipment is basically self contained, however, there are a number of sources where hydrogen could escape. Some of these are as follows:

(a) During testing of hydrogen for oxygen content.

(b) During draining of condensate.

(c) During balloon filling (holes, etc.).

(d) Loose fittings, faulty gaskets and defective components.

(e) Improperly closed valves.

(f) Poor hose connections.

(g) Low electrolyte level in the cells.

(h) During maintenance when parts of the system are taken apart.

(i) During freezeup i.e. water seal, manometers, etc.

1.5.2.2 Sources of Ignition And Their Prevention Following is a list of the common sources of ignition and methods for their prevention.

(a) Static Electricity

(i) Ground yourself frequently on the light switch, generator frame, or other metal objects which are grounded.

(ii) Fill balloons slowly to prevent static buildup.

(iii) Wear anti static clothing. Avoid cloth such as nylon which is prone to static build up.

(iv) Ensure that all metal equipment, cabinets etc. are properly grounded.

(b) Sparks

(i) Do not short out the electrolytic cells by placing tools or other metal objects on the buss bars.

(ii) Handle tools carefully. Ideally tools should be made of non sparking material such as brass.

(ii) The overhead door guides should be well greased. The frame should be grounded and the doors should be opened and closed slowly.

(c) Open Flame - Smoking

(i) Post and enforce NO SMOKING signs.

(ii) Use only heaters that are approved for hazardous locations. For emergency heating with Herman Nelson type heaters, ensure that they are located at least 8 meters downwind from the building.

(d) Electrical Tools

(i) Avoid using power tools in the building. If power tools must be used, shut down the generating system and ensure that the room is well ventilated. Station staff are forbidden to use power tools in the hydrogen building.

(ii) Turn off the power when changing light bulbs or replacing electrical components in the generator.

(e) Batteries

(i) Do not bring battery operated devices into the building i.e. flashlights, Radiosonde instruments, etc.

(ii) When electrical meters must be used in the room to test live circuits, ensure that the room is well ventilated and that valve V-1 is in the 'VENT' position.

(f) Spontaneous Combustion

(i) Do not let oily rags accumulate. Keep them in approved closed containers.

(ii) Ensure that all garbage is removed on regular basis.

(g) Faulty Equipment

(i) Ensure that the generator and all safety equipment is operating properly. Carry out preventive and corrective maintenance as required.

(h) Improper Operating Procedures

(i) Follow proper balloon filling and handling procedures.

1.5.3 FIRE FIGHTING PROCEDURES Any fire in the hydrogen building is extremely dangerous. Safety of personnel is the primary concern. The operator should know the location, and be familiar with the use, of the fire extinguishers in the hydrogen building, and at all times have a planned route out of the building in case of emergency. If there is any doubt at all about the ability to safely extinguish a fire, the person should get out of the building and notify the authorities. Prior to filling a balloon it is recommended that one of the inflation room overhead doors be partially open. This ensures access to the outside in the event of a mishap, and allows better circulation of air. The door should not be raised too high as it may block the ceiling vent. In those buildings equipped with Gas Alarm Systems, should the alarm go off, evacuate the building and do not re-enter it until the Gas Monitor indicates that gas concentration has dropped to below the warning level. It is the responsibility of the OIC and Safety Officer to ensure that the staff are familiar with fire fighting procedures.

1.5.3.1 Hydrogen Fed Fire If a hydrogen fire is burning, there is little chance of an explosion because the gas is being consumed by the flame.

1.5.3.1.1 The danger would arise if the source of ignition backed into the container of contaminated gas i.e. gasholder or tank. For this reason the source of gas should be shut off.

1.5.3.1.2 The following procedures can be used in fighting a hydrogen fed fire keeping in mind that the safety of the operator is always the primary concern:

(a) Shut off the source of gas if it can be done safely. If not, get out of the building quickly and keep everyone else out.

(b) Shut off power to the building.

(c) Call the appropriate authorities, i.e. fire marshall, airport manager, OIC.

**WARNING**

Under no circumstances should an attempt be made to extinguish a hydrogen fed fire with an extinguisher. The release of chemicals from the extinguisher could disperse the hydrogen into the air producing an explosive mixture.

1.5.3.2 Non Hydrogen Fed Fires If a fire other than hydrogen fed is burning, the following procedures should be adhered to, if it is possible to do so safely. If there is any doubt as to whether the fire can be extinguished safely, get out of the building quickly and notify the appropriate authorities.

(a) Shut off any potential source of hydrogen. For example close the valves on the storage tank.

(b) Shut off the power to the building.

(c) Use a dry chemical extinguisher to thoroughly extinguish the fire.

(d) Notify appropriate authorities that a fire has occurred.

1.5.4 SAFETY STATION All personnel should be familiar with the use and location of all safety supplies. The safety station should be equipped with the following:

1.5.4.1 First Aid Kit A standard fully stocked first aid kit complete with instructions and a log book should be kept in the generating room.

1.5.4.2 Eye Wash Station An eye wash station complete with a full bottle of solution and attached eye cup should be mounted on the wall complete with instructions. The location should be chosen so that in an emergency, the bottle can be found without the use of eyes. The bottle should not be corked and the eye cup should be kept clean. Outdated and partially used bottles should be discarded. Several spare bottles should be kept on hand.

1.5.4.3 Neutralite A full bottle of neutralite with the cork removed and a valid expiry date should be kept in an easily accessible location. The solution is used to neutralize acid and base chemicals which have been spilled on skin, clothing and equipment. Skin exposed to electrolyte should be washed quickly and thoroughly with neutralite. Several corked spare bottles should be kept on hand. Expired bottles should be discarded.

1.5.5 CORROSIVE CHEMICALS There are at least two corrosive chemicals found in the hydrogen building, exposure to which can cause skin irritation, severe burns and possibly blindness. These are Hydrochloric Acid used in the Fyrite Tester, and Potassium Hydroxide (Caustic Potash) used to make up the electrolyte solution for the cells.

1.5.5.1 Handling Chemicals Following precautions should be taken when handling any type of corrosive chemicals:

(a) Avoid direct skin contact with the chemicals.

(b) Do not inhale fumes or dust from the chemicals.

(c) Wear protective clothing: goggles or face mask, dustmask, gloves, rubber boots and apron.

(d) Caustic Potash in dry form should be stored in labelled, closed containers and kept dry.

(e) Mixed electrolyte solution should be stored in plastic, closed containers, labelled, and stored out of the way of traffic.

(f) Chemical spills should be neutralized and cleaned up immediately.

1.5.5.2 First Aid For Corrosive Chemicals Should chemicals get into the eyes, immediately douse the eyes with the entire contents of the eyewash bottle, and obtain immediate medical attention. Specific instructions that pertain to the use of the eye wash station and followup treatment should be available on each station. Each employee should be familiar with these instructions.

1.5.5.2.1 Should chemicals come in contact with an area of the body other than the eyes, wash the area thoroughly with Neutralite and then wash under running water.

1.5.5.2.2 Operators should wash up after working on the electrolyser because traces of caustic can always be found on the equipment. Severe chemical burns, after the initial first aid, should receive immediate medical attention.

1.5.6 PROTECTIVE CLOTHING A complete set of good quality protective clothing should be kept on station for use by the staff. These should include goggles, gloves, face mask and dust mask.

1.5.6.1 Gloves The gloves should be made of chemical resistant material which retains its flexibility in cold temperatures. They should provide a comfortable fit and extend well above the wrist. They should be snug at the opening so that chemicals can't spill inside, but not too tight in case they have to be removed quickly.

1.5.6.1.1 Disposable gloves can be used for small jobs but are not recommended for electrolyte mixing. They tear easily and are difficult to remove quickly.

1.5.6.1.2 Several sizes of gloves should be stocked. After handling chemicals the gloves should be rinsed with neutralite then water and put back in their proper storage place.

1.5.6.2 Face Mask and Goggles Full face protection is recommended when working around chemicals. Vertical, swivel type, clear plastic face masks with adjustable head straps are available. For minimum protection, eye goggles with a good fit must be worn. Whichever type is used it must provide a good fit and must not restrict visibility. Several types and sizes should be stocked. After use, the face mask or goggles should be cleaned and put back in a proper storage place.

1.5.6.3 Apron The apron should be made of chemical resistant material which retains its flexibility in cold temperatures. It should be comfortable and knee length. The operator should be able to bend down in it without the apron getting in the way. Several types and sizes should be kept on hand. After use the apron should be cleaned and returned to its proper storage area.

1.5.6.4 Dust Mask A supply of disposable dust masks should be kept on station. These fit over the mouth and have an elastic band that goes around the head. The dust mask should be used when mixing chemicals and when handling asbestos material such as the wrapping in the wall vent heater.

1.5.7 FIRE EXTINGUISHERS Multi purpose ABC type, low temperature fire extinguishers should be used in the hydrogen building. They should be wall mounted near doorways and in easily accessible locations. A minimum rating of 10A-40 BC is acceptable. 10A indicates that an individual can extinguish 10 cubic feet of loose packed Class A ordinary combustible material fully ignited. 40B means that an individual can extinguish a well established flammable liquid fire covering 40 square feet. C indicates that the chemical is non-conductive and can be used on electrical fires.

1.5.7.1 When refilling the extinguisher it is essential that the type of dry chemical specified on the extinguisher be used. A coarser chemical could cause clogging and reduce the flow. Two different chemicals if mixed might react with each other and lead to pressurizing and rupturing of the cylinder. Because extinguishers are often exposed to freezing temperatures only nitrogen filled cartridges should be used. Spare cartridges and a supply of dry chemicals should be kept on station for recharging of extinguishers.

1.5.7.2 Wherever possible request the local fire marshall to inspect the hydrogen building. The fire department should be familiar with the physical layout of the building and of the dangers that exist. Regular inspections of the fire extinguishers should be carried out, and dates marked on the inspection tag.

# SECTION 2

# THEORY OF OPERATION

## THE CONTROL/ALARM UNIT

2.1 The Control/Alarm Unit, see figure 2-1, is located in a non hazardous area outside the generating room. It is used to supply power to the Electrolytic Hydrogen Generator. Four circuits make up the Control/Alarm System:

(a) The Main Control Circuit

(b) The Alarm Bell Circuit

(c) The Gas Detector Circuit

(d) The Fire Alarm Circuit

Each of these circuits is described in this section. Reference drawings for the Control/Alarm Unit are figure 7-1 the circuit diagram, and figure 7-2 the wiring diagram.

2.1.1 THE MAIN CONTROL CIRCUIT Normally open contacts of relay K1 are connected into both sides of the 240 volt line between the distribution panel and the Electrolytic Hydrogen Generator. When K1 is energized, these contacts close and power is supplied through the contacts to the Hydrogen Generator.

2.1.1.1 The contacts are controlled by a coil connected into the 120 volt Main Control Circuit. The coil is in series with the following devices:

(a) F1 - A 1 amp Slo-Blo fuse which protects the circuit.

(b) Gas Warn and Gas Alarm A Contacts - Relay contacts for the Gas Detector System. They are normally in the closed position but will open the circuit when the gas detector has been activated.

(c) K2a contact - A relay contact for the Fire Detector. It is normally closed but will open the circuit when the fire detector has been activated.

(d) K1a contact - A normally open holding relay contact for the K1 coil. The S2 'ENABLE' button is connected parallel to this contact and is used to energize the coil and close K1a contact if all other contacts and switches in the circuit are closed.

(e) S1 - A 'NORMAL/DISABLE' switch which opens or closes the circuit to the K1 coil.

(f) S5 - An 'EMERG. OFF' button located on the cubicle door of the Hydrogen Generator. It is normally in the closed position and is used to open the circuit and shut off the power to the generator in emergency situations.

(g) S10 - A Low Pressure switch connected into the low pressure line of the generator. The switch will open the main control circuit if line pressure drops below a preset level. Refer to para. 4.4.1 (b) for S10 bypass instructions during start up when there is little or no pressure in the line.

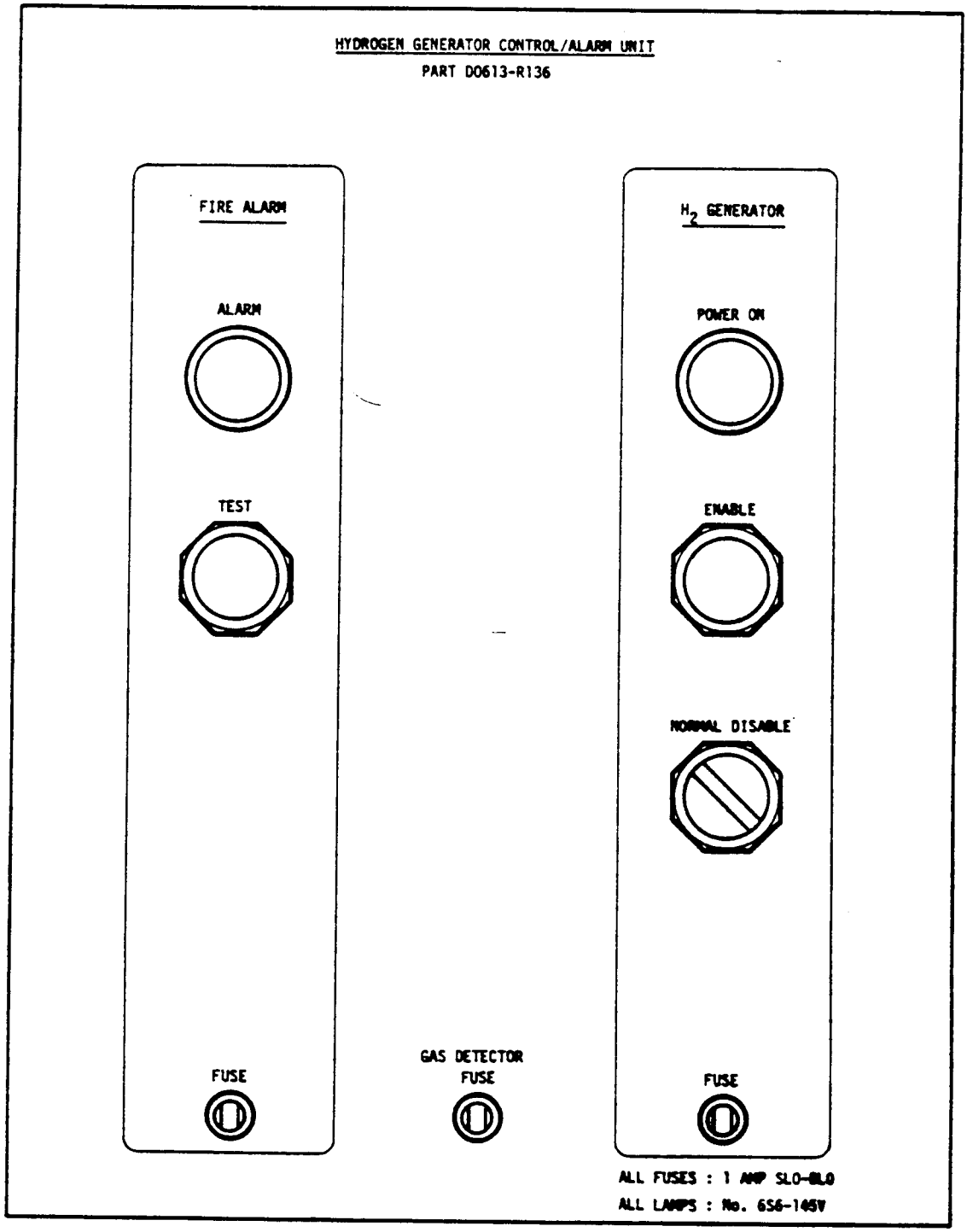



Figure 2-1 The Control Alarm Unit

2.1.1.2 When all these devices are in the closed position (S10 bypassed if necessary), the circuit is complete and K1 can be energized by pressing S2. Connected across the K1 coil is a green 'POWER ON' light DS1 which lights up to indicate that the coil is energized and the main circuit is powered up.

2.1.2 **THE ALARM BELL CIRCUIT** Connected parallel to the main circuit is the alarm bell AB1. It is mounted on the outside of the hydrogen building together with two red lights.

2.1.2.1 Normally the circuit to the alarm bell is open and AB1 is inactive. Several devices can energize the circuit and activate the Alarm System:

2.1.2.1.1 K2b is the second relay contact for the fire detection system. When the fire detector is activated, contact K2a in the main circuit opens and shuts off the power to the generator. At the same time K2b contact in the Alarm Bell Circuit closes, completing the circuit to the bell, causing it to ring.

2.1.2.1.2 Gas Warn B is a normally open relay contact controlled by the gas detection system. When the gas Warn relay is activated, the warn A contact in the main circuit opens shutting off the power to the generator. At the same time the Gas Warn B contact in the Alarm Bell circuit closes, completing the circuit to the bell and causing it to ring.

2.1.2.1.3 K1B is the second relay contact for K1 coil. The contact is normally closed and when the K1 coil is energized as during normal operation, the contact opens. If the coil deenergizes for any reason, the K1b contact will close and the bell will ring. To stop the ringing, S1 which is connected in series with the contact, has to be switched to the 'DISABLE' position. This action opens the circuit to the alarm bell.

2.1.2.2 When energized, the K2b, the Gas Warn B and Gas Alarm B contacts are parallel to, and therefore independent of, S1 and K1b. Even when S1 is in the 'DISABLE' position, the alarm will sound if these contacts are closed by their respective circuits.

2.1.3 **THE GAS DETECTOR CIRCUIT** The Gas Detector System is connected into the Control/Alarm Unit parallel to the Main Circuit. The main line of this circuit consists of fuse F2 in series with the Gas Detector Control Circuit.

2.1.3.1 The Gas Detector Control Circuit consists of the CD800W Bacharch Gas Alarm System and is described in detail in para. 2.2. Parallel to the Control Circuit are three sets of contacts, and indicating lights L2. Light L2 is mounted outside the building together with the alarm bell.

2.1.3.2 The Gas Warn, Gas Alarm and Gas Detector Fail contacts are normally open and light L2 is OFF. If the Gas Detector Control Circuit causes any of these contacts to close, the circuit to L2 will be completed and the light will go ON. At the same time auxiliary Gas Warn contact (or both the Gas Warn and Alarm contacts) in the Main Circuit will open to shut down the generator and the Alarm Bell Circuit will close setting off the alarm bell.

2.1.4 **THE FIRE ALARM CIRCUIT** The Fire Alarm Circuit is connected into the Control/Alarm Unit parallel to the Main Circuit. A Fire Detector FD1, contact K2, and 'TEST' button S3 are connected in parallel. On some systems a second Detector is connected parallel to the first one. Normally these devices are in open position. If the detector is activated, the corresponding contact will close, completing the circuit through S2 and energizing coil K2. When the coil is energized , contact K2 closes. At the same time auxiliary K2a in the main circuit opens shutting off the generator, and auxiliary contact K2b in the Alarm Bell Circuit activates the alarm bell.

2.1.4.1 S3 is used for testing the Fire Alarm Circuit. When S3 is pressed, the circuit to the coil is completed and the alarm is activated. S2 is the 'ENABLE' button for the Main Control Alarm Circuit. It also serves as a reset for the fire alarm. When pressed, it will open the circuit to deenergizing coil K2 causing the K2 contact to open. The system cannot be reset when one of the detectors has been activated.

2.1.4.2 Connected across the K2 coil are two lights. DS2 is a red 'ALARM' indicator light on the Control Alarm Unit cover. L1 is a red light mounted beside the alarm bell outside the building. Both of these lights go ON whenever the Fire Alarm Circuit has been activated.

## THE GAS DETECTOR/ALARM SYSTEM - CD800W

2.2 The Gas Detector/Alarm Unit is part of the generator safety system. It is used to measure the concentration of hydrogen in the atmosphere of the generating room. When preset levels of hydrogen concentration are exceeded, Warn and Alarm circuits in the Control Module are activated resulting in shutdown of the Electrolytic Hydrogen Generator and sounding of the Alarm.

The Gas Alarm System consists of a gas detector mounted above the Hydrogen Generator and a Control Module installed in a non hazardous location.

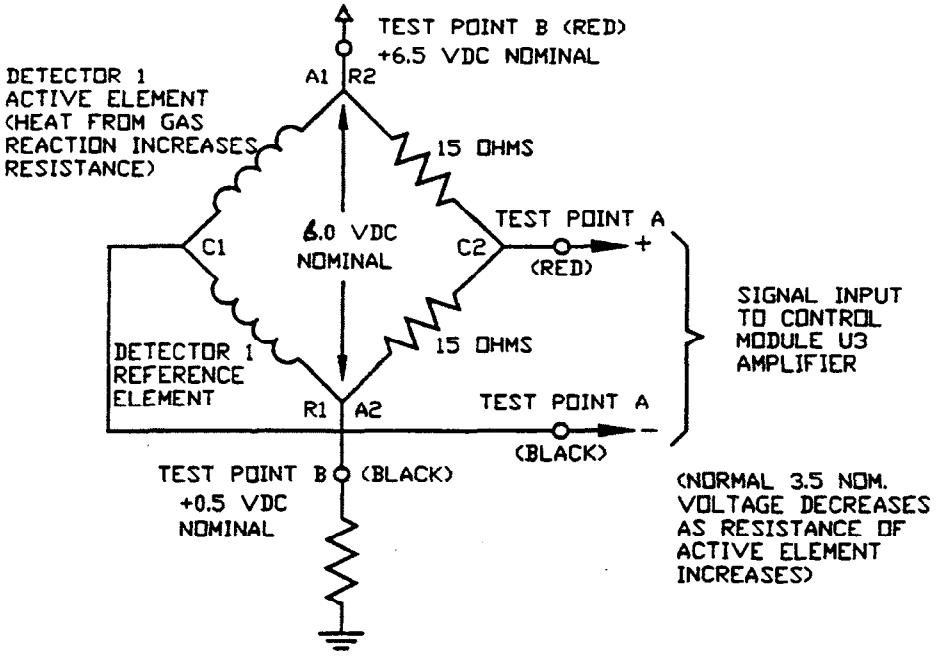



Figure 2-2 Detector Bridge Circuitry

2.2.1 **THE DETECTOR** The Detector consists of a sensing element mounted inside a shield assembly. The presence of hydrogen at a sensor induces a reaction on the surface of the element. The heat that results from the reaction affects the temperature and therefore the electrical resistance of the sensing element. This resistance of the active element is compared to an inactive one which is at the same ambient temperature. The difference in electrical resistance between the two elements produces a signal current which is then used to activate the Warn and Alarm circuits and the '%L.E.L.' (Lower Explosive Level) meter.

**CAUTION**

Extra care must be taken when storing or handling the detector sensor element to ensure that it is not poisoned by aerosol sprays (such as WD40), polishes, waxes, and any lubricants containing silicones.

2.2.1.1 The electrical balance at zero hydrogen concentration is created by a bridge circuit made up of paired resistance's, refer to Figure 2-2.

2.2.1.2 A 6.0 dc voltage is applied across contacts A1 and R1 of the balanced bridge. The output signals from the Reference and Active elements are fed to a differential amplifier in the Control Module. Under balanced conditions when there is no hydrogen at the sensor both amplifier inputs remain at a nominal 3.5 volt operating level, therefore, no voltage difference and no amplification occurs. If hydrogen is now introduced at the sensor, the heat produced by the reaction will cause the resistance of the active element to increase, resulting in a voltage imbalance in the bridge circuit. A differential voltage will appear between the two amplifier inputs and amplification will take place. The resulting amplifier output is applied to the '%L.E.L.' meter and to the Warn and Alarm circuits in the Control Module.

2.2.2 **THE CONTROL MODULE** The Control Module serves the following functions:

(a) It supplies regulated voltage to the detector.

(b) It signals a failure in the detector power circuit.

(c) It receives signal inputs from the detector.

(d) It compares the signal from the detector against a reference voltage and triggers Warn and Alarm circuits.

(e) It tests the system by simulating a signal from the detector.

(f) It resets the Warn and Alarm Relays.

2.2.2.1 **Indicating Panel** Visible through a glass window of the Control Module cover is an indicating panel, see figure 2-3. It has a meter and four indicating lights.

- The '%L.E.L.' meter continuously indicates hydrogen concentration at the detector in terms of percentage of the lower explosive limit. The lower explosive limit of hydrogen in air is 4%.. An indication of 100% on the meter is equivalent to a 4% mixture of hydrogen.

- The green 'PILOT' light is ON whenever the Control Module circuits are energized.
- The blue 'FAIL' light goes ON if the detector circuits.
- The yellow 'WARN' light goes ON when warn levels of hydrogen concentration are reached (normally 20% of L.E.L.).
- A Test Function is coupled with the 'WARN' light and is used to simulate a high gas concentration condition. When the 'TEST' button is pressed, a circuit is closed from ground to input of differential amplifier U3. The result is an imbalance between the two inputs to U3 such as would be caused by the detector of 100% L.E.L. hydrogen/air mixture. When the button is pressed, the meter pointer deflects full scale and the Warn and Alarm circuits are activated.
- The red 'ALARM' light goes ON when alarm levels of hydrogen concentration are reached (normally 40% of L.E.L.

2.2.2.2 **Reset** A'RESET' button is located on the cover of the Control Module. Its purpose is to reset the internal relays which were triggered by Warn or Alarm signals either from the detector or the test circuit. The relays can be reset only when gas concentration drops below the triggering level (normally 20% L.E.L.).

2.2.2.3 **The Circuit Board** A printed circuit is mounted inside the Control Module behind the indicating panel. Most of the circuitry for the Gas Detector/Alarm System is located on this board. The Warn relay, Alarm relay and Fail relay are mounted on the board and activate their respective circuits when triggered. Six potentiometers on the board permit adjustment of the levels of the various signals, see figure 2-4.

- The 'RANGE' pot sets the meter pointer of the '%L.E.L.' meter for the desired deflection when the 'TEST' button is pressed. Normal setting is 100% deflection.

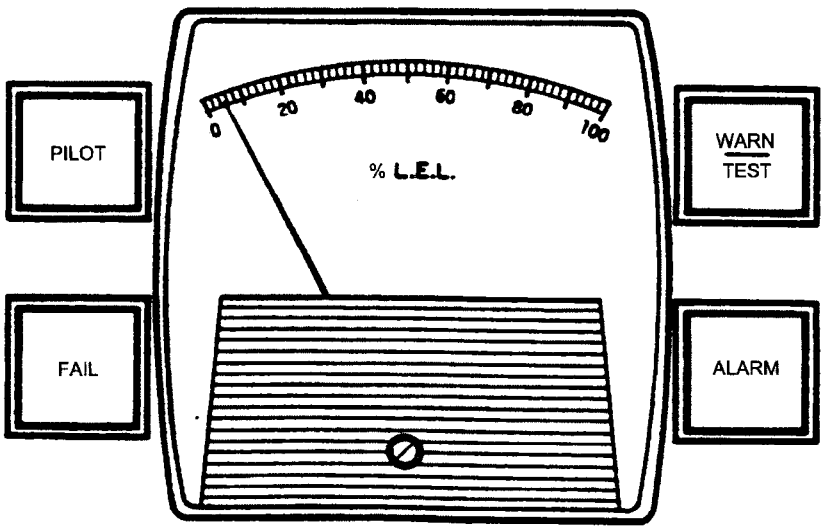



Figure 2-3 The Control Module Indicating Panel

- The 'ALARM' pot sets the level at which the Alarm circuit is triggered. Normally the level is present at 40% L.E.L.
- The 'WARN' pot sets the level at which the Warn circuit is triggered. Normally the level is present at 20% L.E.L.
- The 'GAIN' pot is used during calibration to set the signal amplification so that the meter reading indicates the correct concentration of gas at the sensor
- The 'VOLT' pot sets the level of the dc voltage that is supplied to the detector Normal level is 6.0 volts dc.
- The 'ZERO' pot sets the voltage level for zero meter reading when there is no hydrogen at the detector
- The 'RECORD' pot is for optional equipment and is not used.

2.2.3 **THE CALIBRATION KIT** A kit is used to calibrate the Gas Alarm System so that the percent L.E.L. concentration showing on the meter is indicative of true concentration of hydrogen present at the Detector. The Kit consists of a Gas Cylinder, a Regulator with two Pressure Gauges and a Sample Cup. The regulator screws into the cylinder and is connected with the rubber hose to the sample cup. The cup is placed over the Detector Head and gas is released into it at a low, steady pressure. A number on the cylinder shows the percent L.E.L. value of the gas inside it. When the sensor is fully exposed to the gas, the meter reading should correspond to the value on the cylinder. The 'GAIN' pot on the circuit board is used to adjust the meter to the required value if the two are different.

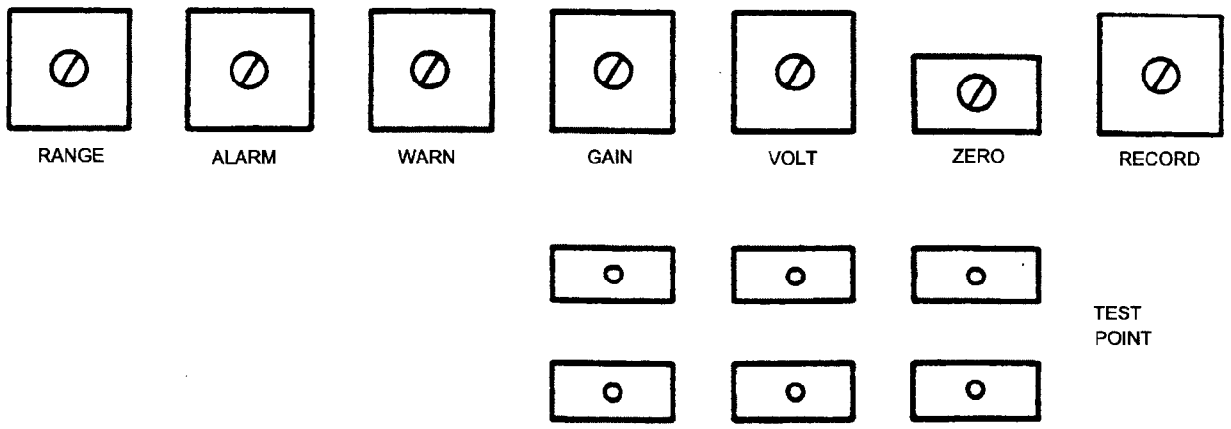



Figure 2-4 Circuit Board Potentiometers

## THE FIRE ALARM SYSTEM

2.3 The Fire Detector is part of the Alarm/Safety System. It consists of one or more detectors connected in parallel. All stations have one detector mounted near the ceiling above the Electrolytic Hydrogen Generator. Those stations which have a heating room attached to the generating room, have a second sensor connected in parallel with the first one. The detectors are connected into the circuits of the Control/Alarm Panel. The detector contact is normally open. When the temperature reaches 60°C the detector is activated and the contact closes completing the circuit to the coil of relay K2 in the Control/Alarm Unit. When the circuit is energized, the Alarm bell AB1 rings, outside Fire Alarm light L1 and indicating panel light DS2 go ON, and contactor K1 is deenergized causing the Hydrogen Generator to shut down.

## THE ELECTROLYTIC HYDROGEN GENERATOR - THE ELECTRICAL SYSTEM

2.4 A cable connects the main 240 volts K1 contacts in the Control/Alarm Panel with TB1 in the electrical cubicle of the Electrolytic Hydrogen Generator. One side of the 240 volt supply connects to terminal 16 and the other side to terminal 14. A neutral wire goes directly from the main distribution panel to terminal 15. The 240 volts between terminals 14 and 16 are used for the main rectifier circuit and the compressor motor. 120 volts between neutral and either terminal 14 or 16 is used for operating the auxiliary circuits. When the K1 contact in the Control/Alarm Unit closes, power is supplied to the Electrolytic Hydrogen Generator.

The generator electrical system is made up of the following circuits:

(a) The Main Rectifier Circuit

(b) The Control Module Circuit

(c) The Fan/Timer Circuit

(d) The Rectifier Control Circuit

(e) The Compressor Control Circuit

(f) The Remote Annunciator Circuit

(g) The Emergency Off Circuit

Reference drawings for the electrical system are figure 7-5, the Wiring Diagram, and figure 7-4, the Circuit Diagram.

2.4.1 **THE MAIN RECTIFIER CIRCUIT** From terminals 14 and 16, the 240 volt line connects to the 'POWER' breaker CB2. When CB2 is off, all the circuits except for the Fan Motor, are deenergized. From CB2 the line connects to the main Rectifier Contactor K1 which has overload protection. When K1 is closed, the Rectifier Circuit is energized, and if all other circuits are normal, power is supplied to the electrolytic cells.

2.4.1.1 From K1, power goes to the Main Rectifier Transformer T1. The output of T1 is connected to diodes D1 and D2. Together with the centre tap configuration of the transformer, the diodes provide full wave rectification and a continuous supply of direct current to the cells. Fuses F1 and F2 provide protection for the diodes.

2.4.1.2 Three parallel capacitors are connected across the main lines. These are power factor correction capacitors and they cancel the effect of the inductive reactance introduced by the Saturable Reactor. They help reduce line losses and increase the efficiency of the circuit. The capacitor circuit is controlled by 'CAPACITOR' circuit breaker CB3.

2.4.2 THE CONTROL MODULE CIRCUIT The control of the current to the cells is accomplished with the Control Module Circuit. Basically the Control Module compares a feedback signal from the main line with a reference signal representing the desired current level. The difference between the two signals is applied to the Saturable Reactor and this affects the current in the main line. For example if line current drops, the feedback signal drops and there will be an increase in the difference between the feedback and reference signals. This will increase the dc saturating current to the saturable reactor allowing more current to flow in the main line. This increase compensates for the initial drop in line current.

2.4.2.1 The feedback signal is derived from a current transformer T3, connected into the main line leading to the main transformer T1. The current in this line is directly proportional to the dc output current of the rectifier. The current from the transformer secondary is rectified by bridge rectifier D3 and passes through a load resistor R3. The voltage drop across the load resistor is used as the feedback signal.

2.4.2.2 The reference signal is derived by applying a regulated voltage across the 'CURRENT ADJUST' potentiometer R6 located on the cubicle door.

2.4.2.3 The two signals are fed to a regulator. The regulator is a plug-in type module which contains an op-amp type difference amplifier. The output of the regulator is fed to the gate of a power field effect transistor. The regulator also contains an op-amp type comparator which will operate an external overload relay K5 if the feedback signal representing actual line current exceeds a preset level. Current to the electrolytic cells is metered at the output of the rectifier, using the DC shunt.

2.4.2.4 The dc saturating current to the saturable reactor is derived by rectifying and smoothing the output of a separate supply transformer which is controlled by the series FET in the output line. The FET is, in turn, controlled by the regulator.

2.4.2.5 When the rectifier is switched to the idle mode, a resistor is switched in to reduce the control signal to the difference amplifier and hence, reduce the output to an idle level. A separate adjustment R7 is provided on the control module for the idle level.

2.4.3 THE FAN/TIMER CIRCUIT A fan is used in the electrical cubicle to keep the components cool and to maintain positive air pressure. The air flow is from the cubicle into the room. An outside source of air is provided through a four inch plastic pipe. This system ensures that there is no possibility of hydrogen contaminated air entering the cubicle. The reason for this precaution is that the electrical components in the cubicle are not approved for hazardous locations and therefore cannot be exposed to hydrogen.

2.4.3.1 The fan operates on 120 volts and is controlled by the 'FAN' circuit breaker CB1. The circuit is independent of the Main Rectifier Circuit and the fan is normally on as long as power is supplied to the Electrolytic Hydrogen Generator.

2.4.3.2 Since purging plays such an important part in the safety system, there are controls which will ensure that the Electrolytic Hydrogen Generator will not start until the cubicle is purged with outside air. The delay required for this purging prior to startup is accomplished through a wind switch S8 in series with a 60-second, time delay relay K3. The wind switch is operated by the movement of the air caused by the fan. When the fan starts, the switch closes, completing the circuit to K3. When the relay is energized, after a delay of 60 seconds, the K3a contact in the Rectifier Control circuit closes, allowing the Electrolytic Hydrogen Generator to be started. When the cubicle door opens, the compartment is depressurized, causing the wind switch to open and the Electrolytic Hydrogen Generator to shut down.

2.4.3.3 When maintenance is being done inside the cubicle, it may be necessary to keep the system energized while tests and adjustments are made. For this reason maintenance switch S9 is connected parallel to contact K3a. By closing the switch when the cubicle door is open, the timer is bypassed allowing the system to be energized. To prevent the possibility of leaving the system in this bypass condition, the switch is automatically deactivated when the cubicle door is closed.

2.4.4 THE RECTIFIER CONTROL CIRCUIT The main rectifier contact K1 will close when the K1 coil in the Rectifier Control circuit is energized. The coil is connected in series with the following devices:

(a) CB4 - 'CONTROL' circuit power breaker

(b) K3a - Timer contact - parallel to maintenance switch S9.

(c) S11 - Pressure Differential switch

(d) S15 - The second Low Limit switch

(e) S2 - 'RECTIFIER STOP' button

(f) K1a - Auxiliary contact for the K1 coil parallel with S1 the rectifier start button

(g) K5a - The Overload relay contact on the Control Module

(h) K1 O.L. - Contacts

2.4.4.1 When devices (a) to (f) are closed, pressing 'RECTIFIER START' S1 will energize the K1 coil and close the K1a relay holding contact. When the coil is energized, the 240 volt K1 contact in the main circuit will close and power will be supplied to the cells. DS1 'RECTIFIER ON' is connected parallel to the K1 coil and will go ON whenever the coil is energized to indicate that power is on.

2.4.4.2 The K1 coil gets power through the K5a relay in the Control Module contact which is in the normally closed position. K5 is used for overload conditions. The K5 coil is in the TC2 regulator circuit. When overload occurs, the K5a contact opens, deenergizing the K1 coil and shutting off the rectifier. At the same time the K5b contact of the Control Module, normally in the open position, closes to completing the circuit through 'OVERLOAD' light DS3 to indicate overload conditions.

2.4.5 THE COMPRESSOR CONTROL CIRCUIT Once the cells produce enough gas to raise the gasholder to the Upper Limit switch S13, and with all the other devices in the circuit closed, the compressor motor starts and the gas is pumped into the storage tank. The compressor motor operates on 240 volts and is connected to CB2 'POWER' circuit breaker through compressor K2 relay normally open contacts.

2.4.5.1 The K2 coil is connected into the 120 volt Compressor Control circuit. When the coil is energized, the compressor K2 contacts close. The coil is connected in series with the following devices;

(a) S12 - High pressure switch

(b) S4 - 'COMPRESSOR STOP' button

(c) K2a - Relay holding contact

(d) S14 - The first Low Limit switch

(e) S16 - Compressor Inlet switch

(f) K2 O.L. - Two overload contacts

2.4.5.2 Connected parallel to the K2a auxiliary contact are 'COMPRESSOR START' button S3 and switch S13. S13 is the Upper Limit switch which automatically starts the compressor when the gasholder is full. It also closes the circuit through the solenoid coil L2 so that the solenoid valve closes whenever the compressor starts. The K2a relay holding contact can be closed manually with S3 or automatically with S13. In either case, if all the devices in the circuit are closed, the K2 coil will be energized causing the main 240 volt K2 contacts to close and the compressor motor to start. Light DS2 'COMPRESSOR ON' is connected across the K2 coil and will illuminate whenever the coil is energized to indicate that the compressor circuit is powered up.

2.4.5.3 The Compressor Control circuit receives its power through K1a of the Rectifier Control circuit (and High Pressure switch S12). This means that the compressor motor cannot be started until the rectifier circuit is energized.

2.4.5.4 The High Pressure switch S12 is wired in the normally closed position completing the circuit to the compressor controls. When the storage tank is full, the switch opens and the compressor control circuit is deenergized.

2.4.5.5 Relay K4 operates in combination with S12. The relay contains two sets of K4 contacts; K4a is used in the control module and K4b in the Remote Annunciator lights circuit. The K4 coil is energized from the Rectifier Control circuit through S12. When S12 is closed 120 volts are supplied to the K4 coil. When the coil is energized the K4a contact in the control module, normally in the closed position, opens and rectifier current is at operational level determined by R6. When S12 opens, the K4a contact closes, switching in the idle circuit, the level for which is determined by variable resistor R7.

2.4.6 <u>THE REMOTE ANNUNCIATOR CIRCUIT</u> Three lights are used to remotely monitor the operation of the Electrolytic Hydrogen Generator. T2 is a step down transformer which provides 12 volts required to operate the lights. These indicators are located in the operations area. On some later installations they have been mounted on the Hydrogen Control/Alarm Unit.

2.4.6.1 The Temperature Light is on to indicate that the temperature at the gasholder is above 40°F. When the temperature drops below this value, thermostat switch S7 opens the circuit causing the light to go off, indicating abnormal conditions.

2.4.6.2 The Compressor Light is on to indicate that the compressor control circuit is normal. Two contacts, connected in parallel, energize the compressor light. These are auxiliary contact K4b and switch S17.

2.4.6.2.1 The auxiliary K4b contact is controlled by the High Pressure switch and the K4 relay. In operational mode, the contact is open but the circuit is still energized through S17. When the unit switches into idle, the contact closes keeping the light on.

2.4.6.2.2 S17, the Higher Upper Limit switch, is in the closed position when the unit is in operational mode, to indicate normal conditions. In idle mode the gasholder bell rises and opens S17. This is still normal and the circuit remains complete through the K4b contact.

2.4.6.2.3 An abnormal condition develops when, in operational mode, S17 is tripped by the bell. This means that S13, which should have started the compressor, failed to do so. This is an indication that something is wrong with the compressor system. When S17 opens, the circuit is broken and the light goes out, alerting the operator to abnormal conditions.

2.4.6.3 The Rectifier Light is on to indicate that the Rectifier circuit is energized. K1b is the auxiliary contact for the K1 coil and completes the circuit through the light. When the K1 coil is energized and power is supplied to the Rectifier, the contact closes and the light goes on to indicate normal operation. If, for any reason, the unit shuts off, the coil is deenergized, the contact opens and the light goes out alerting the operator to abnormal conditions.

2.4.7 THE EMERGENCY OFF CIRCUIT Two devices on the Electrolytic Hydrogen Generator are connected into the Control/Alarm Panel:

(a) S5 is the 'EMERGENCY OFF' button on the front of the cubicle door.

(b) S10 is the Low Pressure switch.

2.4.7.1 These devices are connected in series and if either one opens, a circuit in the Control/Alarm Unit is deenergized, causing the main power supply contact K1 to open.

2.4.7.2 Since these devices are activated only during abnormal conditions, they are wired into the Alarm System and will cause the bell to ring.

## THE ELECTROLYTIC HYDROGEN GENERATOR - THE GAS FLOW SYSTEM

2.5 This section shows how hydrogen is produced in cells and traces the gas flow from the cells through various components into the storage tank. The purpose and operation of each component is detailed. Reference figure 7-3, Equipment and Piping diagram.

2.5.1 THE CELL - OPERATION Direct current is supplied from the cubicle to the cells through copper buss bars. The cells are connected in series in such a way that the cathode of one cell is connected to the anode of the next see figure 2-5.

2.5.1.1 Each cell consists of a cathode and anode separated by an asbestos skirt. The Cathode/Anode/Skirt assembly fits inside a steel tank filled with electrolyte.

2.5.1.2 The anode is made of two perforated metal plates 1.5 cm apart welded together at the sides. Two steel rods welded to the top serve as terminals for the anode. The anode fits inside a woven asbestos cloth called the skirt. At the top the skirt is clamped securely around a hollow metal container. The container narrows towards the top where it is welded to the cell cover. The terminal rods from the anode fit through the hollow container and protrude above the cell cover. Insulating spacers around the rods ensure that the anode does not touch the metal container.

2.5.1.3 The cathode consists of two metal plates 3 cm apart welded together at the sides with two rods extending from the top to serve as terminals. The anode, with the skirt around it, fits between the plates of the cathode. The terminal rods from the cathode go outside the skirt and protrude upwards through the cell cover.

2.5.1.4 The cathode, anode and skirt, together, fit inside the cell tank. Legs made of insulating material on the bottom of the anode and cathode provide support and insulate the electrodes from the tank bottom. A spacer on the side of the cathode ensures that it does not touch the tank wall. Insulators fit over the terminals and screw into the cell cover. These insulators seal the space around the terminal rods to prevent gas leaks and they insulate the rods from the cell cover. A gasket between the cell cover and the tank provides a seal when the two sections are bolted together.

2.5.1.5 Two pipes are welded to the cell cover. They open to the inside of the cell; one into the anode section inside the skirt; the other into the cathode section outside the skirt. Oxygen and hydrogen are taken out through these pipes from their respective compartments.

2.5.2 THE CELL - GAS PRODUCTION The cathode and anode electrodes are immersed in a solution of electrolyte. When the generator is turned on, a voltage potential is created across the electrodes. As current flows from the cathode to the anode. It causes hydrogen to be released from the water at the cathode, and oxygen at the anode. The greater the current, the more gas is released.

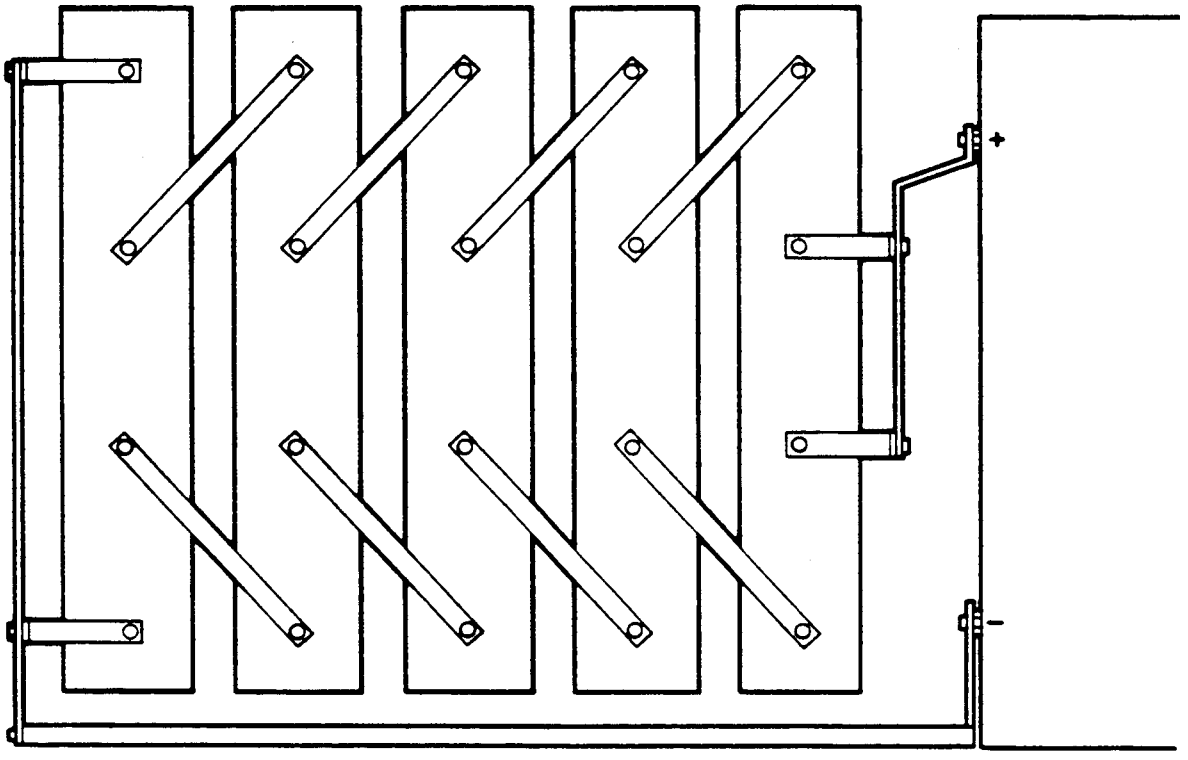



Figure 2-5 Cells Connected in Series

2.5.2.1 The cathode and anode are separated by the asbestos skirt. When wet, the skirt allows electrolyte to pass through it so that current flow can be maintained but it prevents oxygen from passing through and mixing with hydrogen. The electrolyte level must be maintained above the skirt, otherwise, it would dry up and the gases could mix.

2.5.2.2 A sight glass mounted on the front of the cell allows the electrolyte level to be monitored. A water feed valve on top of the cell is connected to a small water storage tank. Whenever the electrolyte level drops too low, the cells can be topped off with distilled or demineralized water from the tank. Though the water gets used up during gas production, the electrolyte itself, except for minor losses, is not consumed.

2.5.2.3 In the event that the electrolyte level drops below the low level mark, vent tubes are inserted through the collector pipes into the cell. The tubes reach down to just above the top of the skirt, one inside the oxygen, and the other inside the hydrogen section. The tubes are rounded on top and are inserted into an overflow pipe which drains into the water seal. The vent tubes serve two functions. First, they allow the gases to vent instead of mixing inside the cell. Second, if pressure inside the cell became too high or if the cell is overfilled, the electrolyte would be forced out of the cells, through the tubes, and into the overflow pipe, and pressure would be relieved.

2.5.3 THE WATER SEAL Refer to figure 2-6. Oxygen and hydrogen are taken from the cell through tygon tubes to separate headers which direct the two gases into a metal container filled with water. This container is called the water seal. Cell pressure forces the two gases into the water seal through narrow open-ended pipes. The gases bubble up through the water into collection pipes, and from there, oxygen is vented into the room and hydrogen is piped to valve V-1.

2.5.3.1 The water seal serves two functions. It maintains equal pressure between the oxygen and hydrogen sections of the cell by allowing excess pressure to be released through the water, and it prevents reverse flow of gas into the cells.

2.5.3.2 An overflow pipe on the side of the water seal permits the water level inside, and thereby the cell pressure, to be adjusted.

2.5.4 THE MANOMETERS Manometers are used to monitor the gas pressure inside the cell and the gasholder. A manometer is a U-shaped glass tube partially filled with liquid. One end of the tube is connected to the gas line and the other end is open to the atmosphere. Gas pressure in the line causes the liquid in the tube to be displaced. The amount of displacement is proportional to the pressure of the gas pushing on it. A scale in the centre of the tube allows the displacement and hence the pressure to be measured.

2.5.4.1 One manometer is connected to the inlet side of the water seal. It measures the pressure in the cell. The second manometer is connected to the outlet side of the waterseal and measures the gasholder pressure.

2.5.4.2 To maintain a positive gas flow from the cell to the gasholder, the cell pressure must be one inch higher than the gasholder pressure.

2.5.5 THE GASHOLDER LINE A stainless steel gas pipe connects the waterseal to valve V-1. V-1 is a ball type valve which allows the gas to be directed either to the vent line or to the gasholder line. In the vent position, any hydrogen produced by the cells is piped through the wall vent to the outside. In the gasholder position, the gas is piped through a coiled hose into the bell.

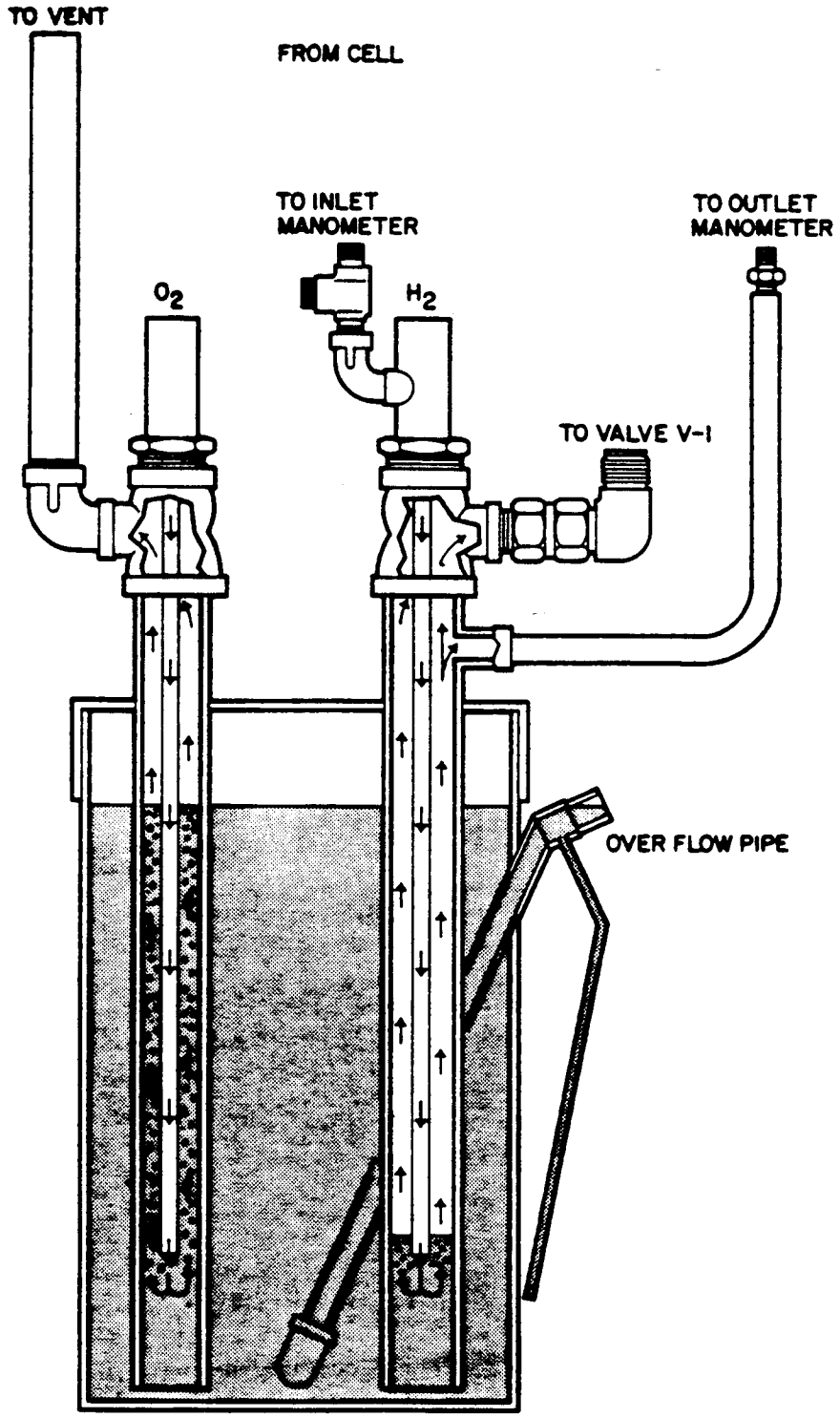



Figure 2-6 The Water Seal

2.5.5.1 Valve V-17 connects into the gasline between the gasholder and the vent. The purpose of this valve is to vent the gas from the gasholder. On system startup or after maintenance when there is a chance that air has entered the gasholder, the system can be purged using V-17. The normal procedure is to allow the bell to rise to the top (with the Compressor Inlet valve closed so that the compressor won't start), then to open V-17 and vent the gas from the gasholder until the bell drops to the low limit switch. This is repeated at least 10 more times or until gas purity is within allowable limits.

2.5.5.2 A secondary line connects from the crankcase of the compressor into the gasholder line to prevent a buildup of pressure in the crankcase. A one p.s.i. check valve in the line prevents reverse flow of gas.

2.5.5.3 A second coiled hose is attached to the top of the gasholder. It is connected to a fixed tube which extends approximately 3/4 way down into the bell. The other end of the hose is attached to the vent pipe. The purpose of the vent tube is to get rid of excess hydrogen from the bell. This happens during idling, and can happen in production mode if the compressor fails to start.

2.5.5.4 Normally the end of the vent tube is submerged in water so that the opening is blocked. When the bell rises above the second upper limit switch, the end of the tube comes out of the water and excess gas is vented. In the 5 cell model, the height of the vent tube is fixed and can not be adjusted.

2.5.6 THE COMPRESSOR LINE When the bell fills with hydrogen and rises to the Upper Limit Switch S13, during normal operation the compressor starts and pumps the gas out of the gasholder into the storage tank.

2.5.6.1 The compressor inlet valve V-3 is located in the gas line between the gasholder and the compressor. It is used to shut off the flow of gas to the compressor. Microswitch S16 works in combination with the valve lever and ensures that the compressor can not start when the valve is shut off. Valve V-3 is used during maintenance work.

2.5.6.2 A secondary line connects into the low pressure gas line between the gasholder and valve V-3. This line connects to the Low Pressure switch S10 located in the electrical cubicle. Pressure in the gas line keeps the switch closed. If there is a pressure drop in the gasholder or in the low pressure line, the switch opens. S10 is electrically in series with the 'EMERGENCY OFF' switch S5 and is connected into the Control/Alarm Circuit. When the switch is activated, a contact in the Control Circuit opens, and power to the Electrolytic Hydrogen Generator is shut off.

2.5.6.3 From V-3 the gas line goes to the Suction valve of the Compressor Head. Up to this point, the line has been under low pressure. Once the gas passes through the compressor, the lines are under high pressure. The purpose of the compressor is to take the gas from the gasholder and pump it into the storage tank to the desired pressure.

2.5.6.4 The Suction valve allows the gas to be drawn from the low pressure line into the compressor cylinder. On the downward stroke of the piston, the suction action causes a metal disc inside the valve to be pulled against a spring away from the inlet opening, thus allowing the gas to be pulled into the cylinder. On the upward stroke of the piston, the pressure of the gas in the cylinder pushes the disc against the opening, sealing the inlet, and allowing the gas to go out only through the outlet. In this way, the valve acts as a check valve, permitting the gas to be drawn in, but not pushed out of, the suction valve.

2.5.6.5 The Discharge valve is connected to the outlet port of the compressor head and permits the gas to be forced out through the valve into the high pressure line. On the upward stroke of the piston, gas pressure pushes a metal disc against a spring away from the outlet opening, allowing the gas to flow past it into the line. Reverse flow is prevented because the suction of the piston and the back pressure from the line forces the plate against the opening, sealing off the outlet.

2.5.7 THE HIGH PRESSURE LINE From the outlet side of the compressor head the gas passes through a series of cooling coils which dissipate some of the heat generated during compression.

2.5.7.1 From the cooling coils the gas passes through a Balston filter which removes water vapour and contaminants from the gas. The filter consists of a Microfibre Tube mounted inside a stainless steel housing.

2.5.7.2 The gas is piped into the inlet side of the housing, passes through the filter tube and goes out the outlet side. The filter tube consists of a 1/8-inch-thick mat of borosilicate microfibres. As the gas passes through the filter, very fine liquid droplets collect and combine on the fibres until large drops are formed. These drops are then forced by gas pressure through the fibres to the outside surface of the filter where they drip to the bottom of the housing.

2.5.7.3 From the bottom of the Balston filter the gas line connects to the Solenoid Unloading valve L2. The purpose of this valve is to relieve the pressure in the high pressure line so that there is no load when the compressor starts. This saves wear and tear on the compressor and the motor.

2.5.7.4 The Solenoid valve is an electro/mechanical device which allows the gas to flow through it when it is deenergized. In this position, the upper spring presses against the top plunger, which pushes a plug away from the valve body, and allows the gas to pass from the In to the Out ports and into the vent line.

2.5.7.5 When the bell reaches the Upper Limit switch S13, the solenoid coil is energized. This creates a magnetic field which attracts the metal plunger and causes it to press against the upper spring away from the plug. With the pressure released from the plug, the lower spring pushes the plug upwards causing it to seal the opening between the two ports. Each time the compressor starts, the Solenoid valve energizes and the line to the vent is closed. When the compressor stops, the solenoid is deenergized and the valve is open to vent.

2.5.7.6 Since the Solenoid valve is connected to the bottom of the Balston filter, all the condensation passes through it. Much of this will be blown out through the vent but some of the condensation will remain in the line. A ball valve V-4 is connected into the line to allow the moisture accumulation to be drained.

2.6.7.7 The main gas line flows from the outlet port of the Balston filter to the High Pressure Check valve (7). A secondary line connects to a Safety Relief valve. Should line pressure reach 125 p.s.i., the Safety valve opens and gas is vented to the outside. The Check valve ensures that there is no reverse flow of gas in the line.

2.5.7.8 A pressure gauge is connected into the line between the Check valve and the Balston filter. This gauge can be used to check for leaks in that section of the line.

2.5.8 THE PULSATION DAMPENER A High Pressure Switch together with a Dampener and a gauge connect into the main line past the check valve. The Pulsation Dampener as the name implies, dampens the pressure fluctuations caused by the compressor in the high pressure line. Uncontrolled, these pulsations could damage the gauge and result in excessive wear in the high pressure switch.

2.5.8.1 The Dampener consists of a plunger, a sealing disc, a bushing and a retaining screw which fit into the main body.

2.5.8.2 The plunger fits through the disc into one of the holes in the bushing where it oscillates freely. The clearance between the plunger and the hole is just enough to give the throttling effect. The bushing contains 5 holes. By rotating the disc, the plunger can be transferred to another hole.

2.5.8.3 Each hole is a different size so that varying degrees of dampening can be achieved. The number one hole has the smallest diameter so that with the least clearance around the plunger, it has the greatest throttling effect. With the Electrolytic Hydrogen Generator, the number 3 hole is used.

2.5.9 THE HIGH PRESSURE SWITCH From the dampener the gas line splits into two. One side connects to the High Pressure gauge and the other to the High Pressure switch (HPS). The gauge is filled with liquid to help dampen vibrations. It indicates the pressure in the high pressure line and can be used in adjusting the High Pressure switch to the proper setting. It can also be used in isolating gas leaks in the High Pressure line.

2.5.9.1 The High Pressure switch S12 is connected into the gas line beside the pressure gauge. The purpose of the switch is to deenergize the compressor circuit and to switch the current to idle level when the line, and hence the tank pressure has reached the desired level.

2.5.9.2 The switch is activated by line pressure pushing against a plastic diaphragm inserted between a thin pressure plate and an actuation plate. This Diaphragm assembly is mounted underneath an adjusting post. Gas pressure causes the plate to push against a pin extending from the bottom of the post. When the pin is pressed, the action is transferred through the centre of the post to a microswitch mounted above the housing causing it to be activated.

2.5.9.3 The sensitivity of the switch is controlled by a spring inside the centre post which opposes the pressure of the Diaphragm. The more tension is applied to the spring, the greater must be the gas pressure in the line to overcome this tension and activate the microswitch. The spring tension can be changed with a large adjusting screw which turns around a centre post. A scale attached to the post shows the pressure in p.s.i. required to activate the switch. Turning the screw clockwise compresses the spring, therefore actuation pressure will be greater. Turning it counter clockwise releases the spring tension and the activation pressure will be lower. The switch is normally set at 100 psi.

2.5.9.4 S12 is connected in the normally closed position so that when pressure is below the activation level, the circuit into which the switch is connected is closed. When line pressure increases to 100 psi, the switch opens causing the following to occur;

(a) The Compressor Control Circuit opens so that the compressor will not start.

(b) The K4 relay is deenergized, switching current to idle level.

2.5.10 STORAGE TANK VALVE V-7 AND BALLOON FILLING VALVE V-9 A two way ball valve V-7 is connected into the line past the High Pressure Switch. This valve can either direct the gas into the storage tank or block the flow at the valve. V-7 can be used effectively in isolating leaks in the high pressure line.

2.5.10.1 The balloon filling line connects into the main line past V-7. The flow in this line is controlled with valve V-9. This is a two way ball valve which in the closed position, cuts off the flow to the filling line and allows gas to flow to the storage tank. When V-9 is in the open position, gas flows from the line and the storage tank to the Balloon Inflation valve.

2.5.10.2 The Inflation valve is designed to limit the rate of gas flow to the balloon and allows control of the rate of balloon inflation. The Inflation valve assembly is mounted on the wall and protrudes into the inflation room. A hose connects the assembly to the filling stand where the balloon is inflated.

2.5.11 THE PRESSURE DIFFERENTIAL SYSTEM A Pressure Differential System (PDS) connects into the high pressure line leading to the storage tank. The PDS is a safety system designed to shut down the Electrolytic Hydrogen Generator in the event of a sudden drop in line pressure. Such a drop is normally an indication of a gas leak which could result in a potentially hazardous situation.

2.5.11.1 The PDS is made up of a Check valve, a Reset valve, a Pressure gauge, and a Pressure Sensitive switch. The switch operates in a similar manner to the HPS. A diaphragm and actuating plate are mounted below a pin extending from the bottom of the adjusting post. Pressure applied from below will push the plate against the pin and the motion is transferred through the post to a microswitch mounted above it.

2.5.11.2 There are two gas lines which connect into the switch, one below and the other above the diaphragm. These lines are isolated from each other. When the pressure above and below the diaphragm and the plate is relatively equal, the plate is not touching the actuator. When pressure in the line above the diaphragm drops, the pressure below pushes the plate up and the switch is activated. The line above the diaphragm is connected directly into the high pressure gas line. The line below the diaphragm is separated from the high pressure line by reset valve V-6 and by the check valve. The check valve ensures that when the pressure in one line drops, the other line is not affected, otherwise, there would be no pressure difference between the two sides and the diaphragm would remain motionless. After the switch has been tripped, V-6 can be used to equalize the pressure so that the switch is reset and the Electrolytic Hydrogen Generator can be restarted.

2.5.11.3 The pressure gauge can be used to check for leaks in the reset valve, the check valve or the switch itself.

2.5.11.4 The sensitivity of the switch can be changed with an adjusting screw which controls the tension of a spring inside the centre post. A scale on the front of the post shows the pressure drop in p.s.i. which would be required to activate the switch. Normally the switch is set so that a one psi pressure drop in the line will shut down the Electrolytic Hydrogen Generator.

2.5.11.5 The PDS, switch S11, is connected into the Rectifier Control Circuit in the normally closed position. It is in series with other devices which complete the circuit to the K1 coil. When a pressure drop activates the switch, the S11 contact opens, the K1 coil is deenergized and the generator shuts down.

2.5.12 THE STORAGE TANK The main gas line protected by the PDS is connected to the high pressure storage tank through two toggle valves. Normally these valves are left in the open position so that gas can be pumped into the tank and to ensure that the tank is protected by the PDS. A gauge between the two valves indicates tank pressure. The gauge can also be used for checking the high pressure line for leaks.

2.5.12.1 On top of the tank a line connects to a safety relief valve and from there through the wall to the outside. The valve is fixed at 125 p.s.i. Should, for any reason, tank pressure exceed the safety limit, the gas would be vented outside through the valve. A second line, controlled by a toggle valve, is also connected from the top of the tank to the outside so that manual venting or purging can be carried out when necessary.

2.5.12.2 From the bottom of the tank a line connects through two toggle valves, V-12 and V-13, to the wall vent. This line is used for blowdown of condensation from the tank. Valve V-12 is closest to the tank and is always left in the open position. It is closed only when maintenance is being carried out on V-13.

# SECTION 3

# INSTALLATION

(Section not finalized)

# SECTION 4

# OPERATING PROCEDURES

## THE CONTROL/ALARM UNIT

4.1 The main purpose of the Control/Alarm Unit is to control the 240 volt power supply to the Hydrogen Generator. When the following circuits are normal, the Hydrogen Generator can be energized.

(a) The availability of power from the main panel.

(b) The Fire Alarm Circuit which will shut the power off when activated.

(c) The Gas Detector Circuit which will shut the power off when activated.

(d) The 'EMERGENCY OFF' switch and the Low Pressure switch which will shut the power off when activated.

4.1.1 START UP PROCEDURES To energize the Control/Alarm Unit proceed as follows:

(a) Turn on the main breakers at the breaker panel.

(b) Ensure that the meter on the Gas Detection System indicates zero or near zero gas concentration.

(c) Turn the 'NORMAL/DISABLE' Select switch S1 to the 'NORMAL' position.

(d) Press the 'ENABLE' pushbutton S2.

NOTE

The alarm bell will ring after S1 has been switched to 'NORMAL' and will stop ringing when the system is enabled.

4.1.1.1 The green 'POWER ON' light DS1 will go ON when contactor K1 is energized. This indicates that power is supplied to the Electrolytic Hydrogen Generator.

4.1.1.2 If the 'POWER ON' light does not illuminate, refer to the maintenance section for corrective action.

4.1.2 SHUT DOWN PROCEDURES To shut the power OFF, turn the Select switch S1 to 'DISABLE'. The 'PILOT' light will go off. Maintenance can be carried out on the Electrolytic Hydrogen Generator with the switch in the 'DISABLE' position.

NOTE

With S1 in the 'DISABLE' position, the 'EMERGENCY OFF' switch and the Low Pressure switch in the Electrolytic Hydrogen Generator are deactivated. The Gas Alarm and the Fire Alarm circuits remain energized and will sound the alarm if activated.

**WARNING**

When maintenance is to be carried out on the Control/Alarm Unit, unless power is required for tests, the main power breaker should be switched off.

4.1.3 REPLACING FUSES There are three Slo-Blo 1 amp fuses connected into the Control/Alarm Unit to protect the various circuits. Fuse F1 is connected into the Main Control Circuit, F2 is in the Gas Detector Circuit and F3 protects the Fire Detector Circuit. These fuses when blown will open the respective circuits. The fuse holder is designed so that it will glow when the fuse has blown. This makes the detection of a faulty fuse easier.

4.1.3.1 To replace a fuse proceed as follows:

(a) Switch off the breaker controlling power to the Control/Alarm Unit.

(b) Push the end of the fuseholder in and twist it in the counterclockwise direction. The holder will pull out together with the fuse.

(c) Replace the fuse with one of equal rating. To replace, push the fuse holder in and twist clockwise.

4.1.3.2 If any of the fuses burn out repeatedly, the cause must be investigated and the fault corrected.

4.1.4 REPLACING INDICATOR LAMPS Two 6W, 145V indicating lamps are used in the Control/Alarm Unit. A red light is used to indicate that the Fire Alarm Circuit has been activated. A green light indicates when the Main Control Circuit supplying power to the Electrolytic Hydrogen Generator is enabled. If one of the lamps is burned out, it can be replaced with a spare as follows:

(a) Unscrew the lens.

(b) Unscrew the faulty lightbulb either with fingers or with the special lamp remover.

(c) Replace the lamp with a new one.

(d) Replace the lens.

THE GAS DETECTOR SYSTEM CD800W

4.2 The purpose of the Gas Detector System is to shut down the power to the Electrolytic Hydrogen Generator and to activate the Gas Alarm Circuit when unsafe levels of hydrogen concentration are detected by the sensor.

4.2.1 START UP OF THE GAS DETECTOR SYSTEM Under normal operating conditions, the Gas Detector System will be ON whenever 120 volts is supplied to the Control/Alarm Unit. The system is independent of the main circuit supplying power to the Electrolytic Hydrogen Generator and will remain ON even if the Select switch is in the 'DISABLE' position.

4.2.1.1 There are four lights and a '%L.E.L.' meter on the front of the unit. Under normal conditions the green 'PILOT' light is ON and the 'FAIL', 'WARN' and 'ALARM' lights are off. The meter should indicate zero gas concentration.

4.2.1.2 If the 'PILOT' light does not go ON when the power breaker is turned on, refer to the maintenance section for proper action.

4.2.1.3 If the 'FAIL' light goes on, it is an indication of problems in the detection circuit. Refer to the maintenance section for proper action.

4.2.1.4 If the 'WARN' light goes on, it is an indication that gas concentration at the sensor has reached 20% L.E.L. The Alarm should have been activated and the power at the Hydrogen Generator should be off.

4.2.1.5 If the 'ALARM' light goes on, it is an indication that gas concentration at the detector has reached 40% L.E.L. The Alarm should be ringing and the power should be off at the Hydrogen Generator.

4.2.1.6 The indicating meter '%L.E.L.' shows actual gas concentration at the sensor.

**WARNING**

Do not enter the hydrogen building when the 'WARN' light is on. Wait until the gas concentration has dropped and the circuits have been reset.

4.2.2 SHUT DOWN OF THE GAS DETECTOR SYSTEM The power supply to the Gas Detector is controlled by the same breaker as the Control/Alarm Unit. This means that the gas detector can not be switched off without turning off the power to the Control/Alarm Unit and hence to the Electrolytic Hydrogen Generator. The reason for this is to ensure that the Generator is not operating without the protection of the Gas Alarm System.

4.2.2.1 At most stations the Hydrogen Generator can not be shut down for any length of time without disrupting the aerological program. If the Gas Detector System becomes unserviceable and can not be repaired because of lack of parts or expertise, it can be bypassed so that the generator continues to operate.

NOTE

This method is to be used only in emergency situations. The system must be repaired and reactivated as quickly as possible.

4.2.2.2 The Gas Detector Circuit is in series with fuse F2 located on the Control/Alarm Unit door. To disconnect this circuit from the whole system, remove fuse F2. This will cause the Gas Detector Contacts in the main Control/Alarm Circuit to remain closed so that the K1 coil can be energized to provide power to the generator.

4.2.3 DAILY CHECKS - GAS DETECTOR SYSTEM Before entering the generating room, a visual check should be made at the Gas Alarm Panel. If any of the following checks are incorrect refer to the maintenance section for proper action.

(a) The 'PILOT' light is ON.

(b) The 'FAIL' light is OFF.

(c) The 'WARN' and 'ALARM' lights are OFF.

(d) The '%L.E.L.' meter reads at or near ZERO.

**WARNING**

Do not enter the hydrogen building when the 'WARN' light is on. Wait until the gas concentration on the indicating meter has dropped below 10%, then reset the Alarm System and investigate the cause.

4.2.4 WEEKLY CHECKS - GAS DETECTOR SYSTEM Each week the following Test and Reset functions of the system are checked. If any of the weekly checks are negative, refer to the maintenance section for corrective action.

(a) Press and hold the 'TEST' button to ensure that the following events occur:

(i) The meter needle indicates 100% L.E.L.

(ii) The 'WARN' and 'ALARM' lights go on.

(iii) The power to the generator is shut off.

(iv) The outdoor Alarm System is activated.

(b) Release the 'TEST' button and press the 'RESET' button to reset the circuits. The following should occur:

(i) The indicating meter should return to zero.

(ii) The 'WARN' and 'ALARM' lights should go out.
(iii) When the 'ENABLE" button on the Control Unit is pressed, the outdoor Alarm System should be activated.

4.2.5 **MONTHLY CHECKS - GAS DETECTOR SYSTEM** The monthly checks consist of measuring the detector voltage, doing a system calibration, and testing the Fail circuit.

4.2.5.1 **Check the Detector Voltage** as follows:

(a) Set the voltmeter on the D.C. 0-10 volt range (a voltmeter with a minimum accuracy of +/-2% should be used).
(b) Read the voltage across the Red and Black test points underneath the VOLT potentiometer on the printed circuit board.

4.2.5.1.1 This reading should be the same as that recorded in the log the last time the Detector Operating Voltage was set (6.0 volts D.C. plus the line loss).

4.2.5.1.2 If the value has changed by an amount greater than +/- 0.1 vdc and you are confident of the accuracy of the voltmeter follow the procedures described in paragraph 5.2.2.7.

4.2.5.2 **Perform System Calibration** - Once a month the gas detector system is calibrated to ensure that the '%L.E.L.' meter reading reflects accurately the concentration level of hydrogen at the sensor. If problems are encountered during calibration, refer to the maintenance section for corrective action. To calibrate proceed as follows:

(a) Ensure that the atmosphere around the detector is free of hydrogen and that the indicator needle reads zero. If it does not, adjust the Zero pot until it does.
(b) Assemble the calibration Test Kit and place the sample Cup over the Detector Head.
(c) Slowly release the test gas from the cylinder by turning the regulator knob clockwise. The flow rate should be between 5 and 8 psi.
(d) Let the meter reading stabilize then adjust the GAIN potentiometer on the circuit board so that the meter reading matches the % L.E.L. value printed on the cylinder.
(e) Close the regulator valve and remove the sample cup. The needle should slowly return to zero.
(f) Reset the Alarm Unit and reactivate the system.

**NOTE**

When operationally possible allow a 4-hour warm up after doing a calibration to avoid the zero from drifting.

4.2.5.3 Check the Fail Circuit - If the 'FAIL' light does not go ON as required, refer to the maintenance section for corrective action. Proceed as follows:

(a) turn the zero potentiometer adjust slowly counterclockwise until the meter indicates 8-10% below zero. The following events should occur:

(b) The K3 Fail Relay should activate and the 'FAIL' light should go on.

(c) The outside Gas Alarm light should go on. The bell will not ring during this check.

(d) Readjust the potentiometer so that the meter reads zero. The two lights should go out.

**NOTE**

There is a 45 second delay after the Fail circuit has been reset, before the Warn and Alarm relays can be activated.

## THE FIRE ALARM SYSTEM

4.3 The purpose of the Fire Alarm is to shut down the power to the generator and to activate the Fire Alarm Circuit when the temperature at the sensor reaches 60°C. The fire alarm system is energized when power is supplied to the Control/Alarm Panel. On the left side of the Control/Alarm Panel is a red light DS2, pushbutton switch

4.3.1 **WEEKLY CHECK - FIRE ALARM SYSTEM** The only regular check of the fire alarm system consists of a weekly test of the circuit. Proceed as follows:

(a) Press the red 'TEST' button S3 on the Control/Alarm panel. Ensure that:

(i) The red 'ALARM' Light DS2 on the panel goes ON.
(ii) The L1 Fire Light outside the building goes ON.
(iii) The alarm bell rings.
(iv) Power to the Electrolytic Hydrogen Generator is cut off.

(b) Reset the circuit by pressing the 'ENABLE' button S2. All the alarms should shut off and power should be restored to the generator.

(c) If there are problems in the Fire Alarm System, refer to the maintenance section for corrective action.

4.3.2 **SHUT DOWN OF THE FIRE ALARM SYSTEM** The Fire Alarm System can not normally be switched off without turning off the power to the control/Alarm Unit and hence to the Electrolytic Hydrogen generator.

4.3.2.1 The reason for this is to ensure that the Generator is not operating without the protection of the Fire Alarm System.

4.3.2.2 If there are problems in the Fire Alarm System, refer to the maintenance section for corrective action.

THE HYDROGEN GENERATOR

4.4 Operational maintenance of the hydrogen generator includes start-up and shutdown procedures plus checks and maintenance carried out on routine basis.

**WARNING**

Before going into the hydrogen building, carry out the daily checks for the Gas Detector System to ensure that the gas concentration in the room is within the safety limits.

4.4.1 START UP OF THE HYDROGEN GENERATOR During initial start-up of the Electrolytic Hydrogen Generator and after maintenance has been done on the unit, special precautions must be taken to ensure that the hydrogen entering the storage tank is pure. Proceed as follows:

(a) Ensure that the valves are in correct positions:

(i) Valve V-1 is in the 'TO VENT' position.

(ii) 'COMPRESSOR INLET' valve V-3 is closed.

(iii) Gasholder Vent valve V-17 is closed.

(iv) Storage Tank valves V-8 are closed.

(b) Press the Reset Lever on the Low Pressure switch. The mercury in the glass bulb should be at the wired end. If the switch will not reset because of lack of pressure in the line, it will have to be bypassed until the pressure builds up. To bypass the switch, connect shorting leads between terminal 4 on TB1 and terminal 4 on TB2.

**WARNING**

Ensure that these leads are disconnected after the generator is activated.

(c) Ensure that the lower Low Limit switch S15 is not being tripped. If necessary, manually pull the weight up a few inches above the switch. S15 is connected into the Rectifier Control Circuit and the Rectifier will not start with the switch in the open position.

(d) Turn on all the breakers inside the cubicle.

(e) Close the cubicle door.

(f) Turn on the main remote breakers supplying power to the Control/Alarm Unit.

(g) Turn the 'NORMAL/DISABLE' switch on the Control/Alarm Unit to 'NORMAL' and press the 'ENABLE' button.

(i) If the green 'POWER ON' light does not go on, refer to the troubleshooting guide in the maintenance section.

(ii) When the system is enabled, power is supplied to the Electrolytic Hydrogen Generator cubicle and with the breakers ON, the fan motor should be running.

(h) Wait 60 seconds for the cubicle to purge and the Time Delay Relay to energize. A soft click will be heard.

(i) Press the 'RECTIFIER START' button on the cubicle door. The green light should go ON to indicate that the Rectifier has started. If it does not start, refer to the troubleshooting guide in the maintenance section.

(j) Adjust the current level to 230 amps. If there is excessive foaming in the headers, reduce the current.

(k) Let the unit run for approximately 10 minutes.

(l) Do gas purity test at valve V-15. If the oxygen content is above 1% do the test on each cell to isolate the faulty one. Refer to the maintenance section for corrective action.

(m) Check the cell pressure at the Inlet Manometer. It should read approximately 7 to 8 inches water column. If necessary, adjust the water level in the water seal to bring the pressure to the required level.

(n) Turn valve V-1 to 'GASHOLDER' position and let the bell rise to the top.

(o) Check the gasholder pressure at the Outlet Manometer. The pressure should be approximately one inch lower than the cell pressure. The gasholder pressure is fixed and can not be adjusted. If necessary, adjust the cell pressure at the water seal.

(p) Open the Gasholder Vent valve V-17 and let the bell drop to the low limit switch.

(q) Repeat steps (n) and (p) ten times. This will ensure that the gasholder is thoroughly purged of air before gas is pumped into the storage tank.

NOTE

Purging of the gasholder is required only during initial start-up or when it is suspected that air might have entered the bell. This could happen during maintenance or if there has been a leak in the low pressure lines.

(r) Turn the 'COMPRESSOR INLET' valve V-3 to the 'OPEN' position.

(s) Allow the bell to rise and trip the Upper Limit switch so that the Compressor starts. If it does not start refer to the troubleshooting guide in the maintenance section.

(t) Let the line pressure build up until the High Pressure switch is activated. Note the pressure at the gauge on the storage tank and check the high pressure line for leaks. Adjust the switch to 100 psi if necessary.

(u) Open the storage tank valve V-8 to allow the gas to enter the tank.

4.4.2 SHUT DOWN OF THE HYDROGEN GENERATOR Prior to doing maintenance on the Electrolytic Hydrogen Generator, except in cases where tests are made on live circuits, the generator must be shut down.

4.4.2.1 Normally this is done as follows:

(a) Press the 'RECTIFIER STOP' button on the cubicle door.

(b) Turn valve V-1 to the 'TO VENT' position.

(c) Close the Storage Tank valve V-8.

(d) Turn the 'NORMAL/DISABLE' switch at the Control Panel to the 'DISABLE' position.

4.4.2.2 In addition when work is being done on the high pressure line, close valve V-8 and reduce line pressure through the Balloon Filling valve with valves V-9 and V-7 in the 'OPEN' position.

4.4.3 DAILY CHECKS - HYDROGEN GENERATOR The following operational maintenance procedures and checks must be carried out each time a balloon is filled:

4.4.3.1 Check the Ammeter Reading Normal setting is 30 amps in idle mode and 230 amps in production mode.

(a) Before adjusting the idle, ensure that the main current level is set at 230 amps.

(b) The idle level will be affected by a change in setting of the production current level.

(c) The idle setting can be changed by adjusting the R7 potentiometer on the Control Module.

4.4.3.2 Check the Gas Purity The purity of hydrogen must be checked at valve V-15 using procedures in para. 4.5.2.

(a) Acceptable level of oxygen in hydrogen is less than 1%. If the level rises above that, a second reading should be taken to confirm the first reading.

(b) If the level is still unacceptable, isolate the problem by taking a reading at each cell.

(c) When the faulty cell is found follow removal and bypass instructions in the maintenance section.

4.4.3.3 Check the Electrolyte Level The level of electrolyte in each cell should always be between the low and high level mark. The cells should be filled to the high level mark with distilled or demineralized water from the holding tank.

4.4.3.4 Check the Storage Tank Pressure The pressure gauge reading at the storage tank should be entered in the log book.

(a) If the pressure has not reached the HPS cut-off setting and there was no system shutdown or extra use of gas, there could be a problem in the compression system.

(b) Refer to the maintenance section for corrective action.

4.4.3.5 Check the Water Levels The water level in the gasholder and the waterseal should be up to the overflow pipe. More water should be added as required.

4.4.3.6 Check the Manometers The outlet manometer which monitors the gasholder pressure should indicate between 6 and 7 inches watercolumn. The inlet manometer which monitors cell pressure should indicate approximately one inch higher than the outlet manometer.

(a) The cell pressure can be adjusted with the overflow pipe on the waterseal.

(b) By raising the pipe and adding more water to the waterseal, the cell pressure can be increased.

(c) Lowering the pipe and allowing the water to drain, will lower the cell pressure.

(d) Manometer reading is taken by adding the displacement from zero on both sides of the tube. See figure 4-1.

(e) If the fluid in the manometer is fluctuating too rapidly to take an accurate reading, reduce the current down to zero. This will stabilize the fluctuations.

4.4.3.7 Condensation Blowdown Moisture condensation from the storage tank should be blown out through the valve on the bottom of the tank. This is done by momentarily pressing down the handle of valve V-13.

(a) Moisture from the Balston Filter can be drained through valve V-4.

(b) The valve should be opened and any moisture accumulation allowed to drain out.

4.4.3.8 Check the Pressure Differential Switch The operation of the PDS can be checked during regular balloon filling.

(a) With the reset valve V-6 closed, proceed with inflation.

(b) As pressure in the line drops, the PDS should trip and switch off the Electrolytic Hydrogen Generator.

(c) To reset the PDS, open valve V-6.

(d) If the PDS is not working properly, follow troubleshooting and corrective procedures in the maintenance section.

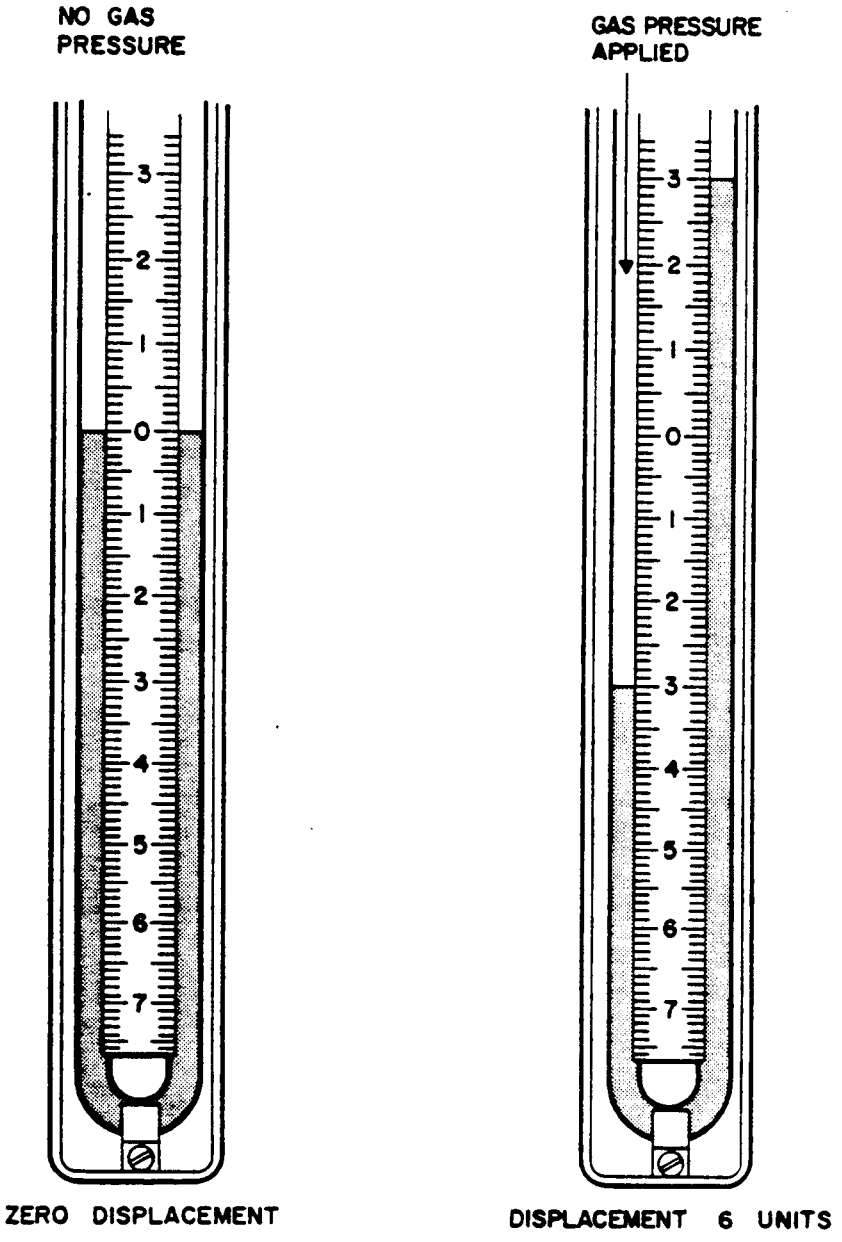



Figure 4-1 Manometer Displacement

4.4.3.9 Check the Wall Vent Heater The heater in the wall vent should be ON to prevent freezeup and blockage of vent pipes.

(a) The vents equipped with a temperature gauge can be checked at a glance. The temperature will vary with weather conditions but should always be above freezing in winter.

(b) Vents without the gauge can be checked by feeling the vent pipes. The pipes should be warm to the touch in winter.

(c) On the outside, the pipes should be checked visually for frost accumulation. Unusual frost buildup is an indication of a problem.

(d) For troubleshooting, repairs, and disassembly of the vents, refer to the maintenance section.

4.4.3.10 Clean Up The Electrolytic Hydrogen Generator and the generating room must be kept clean. Caustic accumulations and oil spills should be quickly cleaned up.

4.4.3.11 Fill Out the Log Book The operating log must be completed each day and after all maintenance work. Unusual or erratic operation should be noted in the log along with the corrective action taken.

4.4.4 WEEKLY CHECKS - HYDROGEN GENERATOR Once a week the following checks are made to ensure the proper operation of the various components in the system.

4.4.4.1 Check the Gas Purity of the Cells Once a week each cell is checked for gas purity.

(a) The amount of oxygen in the hydrogen must be below 1%. This check should be done while the generator is turned on so that gas is produced in the cells.

(b) If one of the cells is producing gas with unacceptable level of oxygen, follow corrective action in the maintenance section.

4.4.4.2 Check the Gas Purity of the Storage Tank This is done by inserting the tester hose into the stainless steel tube at the bottom of the tank or into the balloon filling line.

(a) Slowly release some of the gas into the line and do a regular gas test.

(b) If gas purity is outside the acceptable limit of 1% oxygen, follow the corrective procedures in the maintenance section.

4.4.4.3 Check the High Pressure Switch Although the operation of the HPS is monitored daily, the actual setting is checked once a week.

(a) Close the valve on the storage tank between the pressure gauge and the tank.

(b) With the generator in production mode, allow the Compressor to build up line pressure until the HPS is activated and the generator switches to idle.

(c) The switch should activate at a pressure not greater than 100 p.s.i. A lower setting can be used if desired. Adjust the setting as follows;

(i) Remove the cover from the back of the HPS.

(ii) Rotate the adjusting nut counterclockwise to increase the pressure or clockwise to decrease the pressure.

(iii) The range scale should be read at the top of the adjusting nut.

(iv) After the adjustment, recheck the activating point by building up the line pressure.

4.4.4.4 Check the Wind Switch The operation of the wind switch can be checked either by opening the cubicle door or covering up the vent holes in the back of the cubicle while the unit is energized.

(a) The sudden drop in cubicle pressure should activate the wind switch and cause the Electrolytic Hydrogen Generator to shut down. If the switch does not trip, check the switch assembly to ensure that nothing is sticking and that the two wires in the end are flexible.

(b) Move the plastic sail up and down to ensure it moves freely.

(c) If problems are encountered, refer to the maintenance section for troubleshooting and corrective procedures.

4.4.4.5 Check the Microswitches Manually activate the following microswitches to ensure proper operation If any of the microswitches are not operating properly, refer to the maintenance section for corrective action.

(a) S13 - the lower of the two Upper Limit switches when pressed should activate the Solenoid valve and start the Compressor.

(i) If the 'COMPRESSOR INLET' valve is closed, the Compressor will not start.

(ii) The Solenoid valve should still energize and a loud click can be heard.

(b) S17 - the higher of the two Upper Limit switches when pressed during operational mode will turn off the Compressor Normal light at the remote indicator lights.

(c) S14 - the higher of the two Low Limit switches when pressed will turn the Compressor off.

(d) S15 - the lower of the two Low Limit switches when pressed will shut the Rectifier off.

(e) S16 - the Compressor Inlet switch should turn the Compressor Off when the 'COMPRESSOR INLET' valve V-3 is turned to the 'CLOSED' position.

4.4.4.6 Check the 'EMERGENCY OFF' Button Press the 'EMERGENCY OFF' button on the cubicle door to ensure that it is operating properly. When the button is pressed, the power supply to the Electrolytic Hydrogen Generator should cut out at the Control/Alarm Panel and the alarm bell should ring.

4.4.4.7 Check the Fyrite Tester Fluid Strength Once a week the fluid strength of the Fyrite Tester should be checked. The acceptable level should be 20% or higher.

(a) If the strength falls below the minimum level, replace the fluid.

(b) For testing and replacing the fluid follow the procedures in paras 4.5.4 and 4.5.5..

4.4.4.8 Check the Fire Alarm System Follow the procedures in para. 4.3.1.

4.4.4.9 Check the Gas Detector System Follow the procedures in para. 4.2.4.

4.4.5 MONTHLY CHECKS - HYDROGEN GENERATOR Once a month the following maintenance is to be carried out to ensure proper operation of the Electrolytic Hydrogen Generator.

4.4.5.1 Measure the Specific Gravity Once a month the specific gravity of each cell is measured with a hydrometer. Procedures for using the hydrometer are found in para. 4.6.2.

(a) The correct specific gravity is between 1.26 and 1.28. The measurement should be taken before the cells are topped off. The electrolyte level should be approximately half way between the low and high level marks.

(b) If the specific gravity is below the limit, increase the strength by following procedures in para. 4.7.3.

4.4.5.2 Check the Air Filter Remove the air filter from the cubicle and check for cleanliness.

(a) Look through the filter at a strong light. The filter is clean if the fibre mesh allows the light to pass through.

(b) If little or no light gets through, the filter can be washed in warm soapy water, rinsed and reused. In some areas it might be necessary to clean the filter more often at certain times of year.

(c) If the filter can not be cleaned or if it is falling apart, it should be replaced.

4.4.5.3 Oil the Fan Motor One drop of the special oil should be placed in the oil port of the fan motor once a month. The motor must not be over-oiled.

4.4.5.4 Change the Compressor Oil The Compressor oil should be changed once a month on the 5 cell units operating in cyclical mode. Proceed as follows:

(a) Switch the Rectifier OFF.

(b) Turn the 'COMPRESSOR INLET' valve to the 'CLOSED' position.

(c) Drain the old oil out of the Compressor crankcase through valve V-2. For faster oil flow, remove the dipstick.

(d) Using a small funnel add 250 ml of new oil through the dipstick hole.

4.4.5.5 Check the Low Pressure Switch Once a month the operation of the Low Pressure switch is checked as follows:

(a) With the Rectifier in operational mode and the gasholder bell riding in the upper half position, open valve V-17 to start venting the gas.

(b) Hold the bell firmly so that it does not lower as the gas is vented. Two people may be required for this step.

(c) As the pressure inside the bell drops, the Low Pressure switch should activate, causing;

(i) The power to the Electrolytic Hydrogen Generator to shut off at the Control/Alarm Unit.

(ii) The alarm bell to ring.

(d) To restart the system, press the Low Pressure switch Reset and the 'ENABLE' button on the Control Unit.

(e) If the switch is not operating properly, refer to the Maintenance Section for corrective action.

4.4.5.6 Check the Time Delay Relay Shut down the generator by opening the cubicle door.

(a) Restart the unit and time how long it takes for the Time Delay Relay to energize. It should take 60 seconds ± 5 seconds. On the 5 cell generator, the time delay is fixed and cannot be adjusted.

(b) If it becomes unserviceable it should be replaced with a spare.

4.4.5.7 Check the Grounding Ensure that all the grounding connections are tight.

(a) Any broken or frayed wires should be replaced.

(b) With an ohmmeter check the resistance between the ground cable and a non-painted surface of the Electrolytic Hydrogen Generator. There should be continuity. If not, recheck the connections.

4.4.5.8 Check the Cell Pressure This procedure is used to check for leaks in the system between the cells and the water seal. Proceed as follows:

(a) During normal plant operation shut off the Compressor.

(b) Reduce the current to zero and turn the Rectifier OFF.

(c) Wait 20 seconds then note the cell pressure at the inlet manometer.

(d) Leave the system for 5 minutes then again read the pressure at the manometer.

(e) The pressure should not decrease by more than one inch watercolumn in the 5 minute period. If it does, bubble check all the fittings on the cell and in the line between the cell and the waterseal (cell gasket, hoses, tubes, valves, etc.).

4.4.5.9 Check the Gasholder Pressure This procedure is used to check the Low Pressure System for leaks. Proceed as follows:

(a) During normal plant operation open the 'COMPRESSOR INLET' valve V-3 and allow the gasholder bell to rise to within one inch of tripping the lower of the two upper limit switches.

(b) Reduce the current to zero and turn off the Rectifier.

(c) Mark the position of the top of the gasholder with respect to one of the vertical pipes.

(d) Note if there is a drop in the height of the gasholder over a one minute period.

(e) A drop in height is an indication of a leak between the water seal and the Compressor. Bubble check all the fittings in the low pressure line and around the gasholder hoses. Check the Gasholder Vent valve V-17 (para. 5.3.1).

4.4.5.10 High Pressure Line Check This procedure is used to check the high pressure system for leaks. Proceed as follows:

(a) During normal plant operation, close the valve between the storage tank and the tank high pressure gauge (V-8).

(b) Allow the pressure to increase until the High Pressure switch shuts off the Compressor.

(c) Observe the pressure reading at the generator or at the tank gauge. The reading should remain constant.

(d) If there is a steady decline in pressure, it is an indication of a leak in the high pressure line. Bubble check all the fittings between the Compressor and the tank.

(e) If there is no leak to the outside of the line, it is possible that the high pressure check valve (7) might be allowing the gas to leak through it and then through the solenoid valve to the vent. Refer to para. 5.3.3.1 for check valve maintenance.

4.4.5.11 Check the Gas Detector System Carry out monthly maintenance on the Gas Detector System as specified in para. 4.2.5.

4.4.6 QUARTERLY CHECKS - HYDROGEN GENERATOR Following checks are to be carried out every 3 months.

4.4.6.1 Replace the Balston Filter Element The frequency of filter replacement is determined by impurities in the gas. The filter element should be changed quarterly unless it has been determined at specified stations that a more frequent change is required or a less frequent change is sufficient. Change the filter as follows:

(a) Shut off the Rectifier.

(b) Turn valve V-1 to 'TO VENT' position.

(c) Close 'COMPRESSOR INLET' valve V-3 and hydrogen to storage tank valve V-7.

(d) Remove the section of the stainless steel tube which connects the bottom of the filter housing to the Solenoid valve.

(e) Unscrew the Tie Nut from the bottom of the housing. The Base and the Bowl will drop out.

(f) Unscrew the element retainer and pull out the filter tube.

(g) Insert the new tube and reassemble the housing.

## THE FYRITE OXYGEN TESTER

4.5 A Fyrite Tester is used daily to check the purity of hydrogen being produced by the cells. The tester must be kept in good working condition to ensure that the readings are accurate. The fluid level and the condition of the sampling assembly should be visually checked each time the tester is used. Once a month and whenever erratic readings indicate that there might be a problem with the tester, the strength of the Fyrite Fluid is checked. Procedures for these checks and for the use and maintenance of the Tester are described in this section.

4.5.1 GENERAL INFORMATION Following are some general rules regarding the use of the Fyrite Tester:

(a) The tester temperature should be as close as possible to the temperature of the gas being tested.

(b) The tester should be held by the plastic fins to prevent the warming of the fluid with body heat.

(c) Set the zero of the scale even with the top of the fluid column and read the oxygen percentage at the same point of the column. The bottom of the curve can also be used as long as both the zero setting and the reading are done at the same point.

(d) The tester should be read within five seconds of taking the gas sample, otherwise an error could result.

**WARNING**

Fyrite Fluid contains Hydrochloric Acid and should not come into contact with skin or clothing. Handle with care and wear protective clothing.

4.5.2 PROCEDURES FOR USING THE FYRITE TESTER Following steps should be taken when testing hydrogen for oxygen content. The oxygen content in hydrogen must be less than 1%. If a reading obtained is higher than the acceptable level, a second reading should be taken to confirm the first. If the level is unacceptable, refer to the maintenance section for corrective action.

(a) Ensure that hydrogen is present in the line where testing is being done. When testing is on the cells or at the hydrogen sampling valve, the generator should be in production mode. For testing the storage tank through the balloon filler, ensure that a steady flow of gas is maintained during the sampling.

(b) Connect the rubber sampling hose of the tester to the sampling valve, open the valve, and squeeze the aspirator bulb 4 or 5 times to purge air from the hose and bulb.

(c) Hold the tester upright, press and release the plunger.

(d) Invert the tester and let the fluid drain to the top.

(e) Turn the tester right side up and let the fluid drain to the bottom.

(f) Repeat steps (c), (d) and (e) two more times.

(g) Hold the tester at 45° angle for 5 seconds to drain fluid droplets from the inside surface.

(h) Press and release the plunger. If the fluid level drops, repeat steps (c) to (h).

(i) Hold the tester upright, loosen the lock nut on the scale and adjust the scale so that the zero mark is lined up with the top of the fluid column.

(j) Tighten the lock nut.

(k) Place the rubber connector tip from the sampling hose on the plunger valve of the tester.

(l) Press the plunger valve with the connector tip and squeeze and release the aspirator bulb 18 times. Immediately after the 18th squeeze and before releasing the bulb, release the connector tip from the plunger so that air does not enter the tester.

(m) Close the sample valve then invert the tester and let the fluid drain into the top chamber.

(n) Turn the tester upright and let the fluid drain into the bottom chamber.

(o) Repeat steps (m) and (n) three more times.

(p) Hold the tester at 45° angle for 5 seconds to drain the fluid droplets from the inside surface.

(g) Hold the tester upright and read the scale at the top of the fluid column. The reading indicates the percentage of oxygen in the hydrogen.

4.5.3 ADJUSTING THE FLUID LEVEL The minimum fluid level in the Fyrite Tester should be no less than 1/8 inch, or no more than 5/8 inch above the bottom of the centre bore so that the zero scale adjustment can be made.

4.5.3.1 To raise the fluid level, use demineralized or distilled water. Hold the tester upright and cover the hole in the centre with a finger. Add the water a few drops at a time into the space around the plunger valve. Work the plunger up and down several times. Repeat until the fluid is at the proper level.

4.5.3.2 To remove excess fluid, remove the Top Cap Assembly. Insert a small diameter glass tube into the fluid. Seal the open end of the tube with a finger and take out the fluid until the desired level is attained. Avoid unnecessary exposure of fluid to air since it will rapidly absorb oxygen and become exhausted.

4.5.3.3 After the fluid level has been changed, its strength should be checked to ensure that it is within the allowable limits.

4.5.4 CHECKING THE FYRITE FLUID STRENGTH The strength of the Fyrite fluid is checked every week to ensure accuracy of readings. The fluid's capacity to absorb oxygen decreases each time a test is made.

4.5.4.1 To check the fluid strength connect the sampling hose assembly to the tester and following normal sampling procedures, take a sample of air. Acceptable readings on a sample of air are 20% or higher.

4.5.4.2 If the reading drops below the acceptable level, replace the Fyrite fluid.

4.5.5 PROCEDURE FOR REPLACEMENT OF FYRITE FLUID When the strength of the Fyrite Fluid drops below the acceptable level, the fluid has to be replaced as follows:

(a) Remove the 4 screws from the Top Cap Ring and pull out the ring, the plastic top cap assembly, and the gasket.

(b) Pour out the old fluid. If pouring it into a sink, keep water running while pouring, and half a minute afterwards.

(c) Rinse all parts with lukewarm water and dry them out.

(d) Install a new top gasket and if necessary, a new spring and/or plunger valve. Arrange all the parts for quick reassembly.

(e) Uncap the fluid refill bottle, pour the fluid into the tester and quickly replace the plunger valve and top cap assembly. Replace the screws and the top cap ring. Tighten the screws by going from one to the next, 1/4 turn each time until firmly tightened. Avoid excessive tightening.

(f) Check the strength of the new fluid as outlined in para. 4.5.4 to ensure it is within limits.

NOTE

To minimize the length of exposure of the fluid to air, the reassembly of the tester after new fluid has been added should be as quick as possible.

4.5.6 CHECKING THE FYRITE TESTER FOR FLUID LEAKAGE It is normal to lose small amounts of fluid after several months of testing. This is due to a loss of fluid vapour during sampling. If a leak is suspected in the Top or the Bottom Cap Assembly, check the tester as follows:

4.5.6.1 To check the Top Assembly for fluid leakage:

(a) Press and release the plunger valve.

(b) Note the scale reading at the top of the fluid column.

(c) Stand the tester upside down overnight in a glass or porcelain dish.

(d) Return the tester to the upright position and after allowing 5 minutes for drainage, press and release the plunger valve.

4.5.6.2 Leakage has occurred if the scale reading is lower than in (b) or if fluid is present in the dish.

4.5.6.3 To check the Bottom Cap Assembly follow steps (a) to (d) but leave the tester standing overnight in the upright position.

4.5.6.4 When a leak has been confirmed, check the rubber and plastic parts for wear. Replace defective parts as required.

4.5.7 REPLACING TESTER PARTS Plastic and rubber parts should be examined whenever fluid is changed and when a leak is suspected. Worn or cracked parts should be replaced keeping the following points in mind:

(a) When replacing the Top Gasket ensure that it is properly centered in the recess provided in the top flange of the tester body.

(b) When installing the plastic Top Cap Assembly, be sure that the assembly is centered on the Top Gasket.

(c) To replace the Top Cap, Plunger valve or Plunger Tip Gasket, remove the four screws from the top and pull out the Top Cap Assembly.

(d) To replace the Plunger Tip Gasket:

(i) Depress the plunger valve against its spring limit and strip the old Tip Gasket from the end of the plunger valve.

(ii) Wet the inside surface of the new gasket then press the plunger against the spring limit and force the gasket over the end of the plunger valve.

(iii) Make sure that the new Tip Gasket is seated uniformly against the mating surface in the plastic top cap.

(e) To replace the Diaphragm:

(i) Stand the tester upside down.

(ii) Remove the 4 screws and the metal Bottom Cap.

(iii) Remove the old diaphragm and center the new one with the letter "N" facing upwards into the Bottom Cap Recess.

(iv) Center the Bottom Cap Assembly in the body recess and reinstall the four screws.

(v) Tighten the screws 1/4 turn at a time making sure not to overtighten.

4.5.8 CHECKING THE ASPIRATOR BULB/SAMPLING ASSEMBLY A defect in the sampling assembly can result in erroneous readings. During each sampling, the tubing, bulb, filter tube, and bushings should be checked visually for cracks and deterioration. When above normal oxygen levels are obtained, a more thorough examination of the sampling assembly should be made to check for defects.

4.5.8.1 To check the Outlet side of the Sampling Assembly seal the hole in the center of the connector tip firmly with a finger. Squeeze the Aspirator Bulb. The bulb should remain firm. If it collapses, check the bulb and the hose to the connector tip for cracks and a tight fit. If there is no apparent leak, replace the red inlet check valve. The rounded end of the valve with the small hole fits into the hose and the flat end with the large hole fits into the bulb.

4.5.8.2 To check the Inlet side of the Sampling Assembly, seal the end of the sampling tube or if the tube is connected to the sampling valve, close the valve. Press the aspirator bulb. If the bulb returns to its original shape in less than 15 seconds, inspect the hose and filter tube. If no defects are found, replace the green outlet check valve. The rounded end with the small hole fits into the bulb and the end with the large hole fits into the hose.

4.5.8.3 The Filter Packing should be replaced when it becomes dirty or clogged. Push the old packing out of the tube with a pencil or a thin rod and push the new packing in the same way.

## THE HYDROMETER

4.6 The hydrometer is a device used to measure the Specific Gravity of the potassium hydroxide solution in the cells. Electrolyte acts as a conductor and allows current to pass through the solution causing oxygen and hydrogen to be released. For maximum gas production and low cell operating temperature it is important that the specific gravity be kept between the recommended levels of 1.26 and 1.28.

4.6.1 GENERAL INFORMATION The hydrometer is made up of a float inside a glass body. A thin plastic tube extends from the bottom of the hydrometer and is inserted into the solution which is to be tested. A thermometer mounted in the bottom section measures the temperature of the sample. A rubber bulb at the top when squeezed and released will draw electrolyte into the glass body. As the electrolyte fills the glass, at a certain point the float will begin to rise with the solution. The float is graduated and the line at which it begins to float is the specific gravity of the solution. The specific gravity is affected by the temperature of the solution. To obtain the final reading, a temperature correction from the thermometer will have to be applied to the Specific Gravity of the sample.

4.6.1.1 When measuring the Specific Gravity, enough of the electrolyte should be drawn in so that the float moves freely inside the glass body. If too much solution is taken in, the float will push against the stopper. If not enough is drawn in, the float will not be lifted off the bottom.

4.6.1.2 The Specific Gravity should be measured when the level of the electrolyte in the cell is half way between the low and high level mark. If the sample is taken just after the cells have been topped off with water, the reading will be low because the solution has been diluted. If the sample is taken when the level is near the lower mark, the reading will be high because the water has been used up in production of the gas and a more concentrated solution is left in the cell.

4.6.2 PROCEDURE FOR USING THE HYDROMETER The following procedure is used to check the specific gravity of the electrolyte. If the corrected specific gravity is outside the acceptable limits the strength of electrolyte will have to be adjusted accordingly.

(a) Ensure that the electrolyte level in the cell is half way between the low and high level marks.

(b) Shut the Electrolytic Hydrogen Generator Off.

(c) Remove the plug from the electrolyte sampling port.

(d) Insert the plastic tube of the tester into the sampling port.

(e) Squeeze and release the rubber bulb on top of the tester and draw enough electrolyte into the body to allow the glass bulb to float freely.

(f) Read the specific gravity at the point where the electrolyte level intersects the scale on the float.

(g) Read the temperature at the thermometer and apply the correction to the specific gravity reading.

## ELECTROLYTE HANDLING AND MIXING

4.7 When a new cell is installed or when the strength of electrolyte is outside the acceptable limits, new electrolyte will have to be mixed and added to the cells. Certain safety precautions must be taken when handling electrolyte.

4.7.1 ELECTROLYTE SAFETY Electrolyte is a solution of potassium hydroxide and water. It is very corrosive to skin, clothing and certain metals. Extreme caution should be exercised when working with electrolyte. The following safety points should be adhered to.

4.7.1.1 Wear protective clothing. Rubber gloves, a face shield and a rubber apron will provide sufficient protection as long as the electrolyte is handled with care.

4.7.1.2 A good supply of Neutralite should be kept within easy reach to wash areas of skin which might come in contact with electrolyte. Outdated Neutralite should be replaced.

4.7.1.3 An eye wash station should be easily accessible to rinse out any electrolyte which might come into contact with the eyes.

4.7.1.4 White vinegar is effective in washing out caustic deposits and any parts which have been exposed to electrolyte.

4.7.2 MIXING ELECTROLYTE Together with the safety rules, the following points should be considered when making up a solution of electrolyte:

(a) Mix the solution in thick plastic or stainless steel containers only. Other types of material may react with the electrolyte.

(b) Always add the caustic potash to the water. Add the chemical slowly and stir with a clean wooden stick or steel rod. Adding the potash too quickly could cause the solution to boil and spatter.

**WARNING**

Do not breathe in the vapour rising from the solution. It will result in throat and nose irritation.

(c) When dissolving the caustic potash in water, heat is evolved and the solution will become hot. Allow the electrolyte to cool to 50°C or less before adding it to the cells.

(d) Use only demineralized or distilled water in mixing the solution.

(e) Each cell has the capacity to hold approximately 5 gal or 23 litres of solution. To mix enough solution for one cell, add 15 lbs. (3 pails) of flake caustic potash to approximately 4 gallons of demineralized water. After adding this solution to the cell, top the cell up with demineralized water.

4.7.3 INCREASING ELECTROLYTE STRENGTH If it is found that the Specific Gravity of the electrolyte is below the minimum acceptable level of 1.26, the strength can be increased as follows;

(a) Refer to figure 4-2, Approximate Makeup Electrolyte Required. The graph shows the number of litres of 51% concentrated electrolyte required to bring the solution up to strength. For example if the specific gravity of the solution is found to be 1.25, it will take 1.7 litres of the concentrate to bring the specific gravity up to 1.28.

(b) To obtain the 51% concentrated solution, add 5 lbs (1 pail) of potassium hydroxide for each 1/2 gallon of demineralized water.

(c) Allow the electrolyte level in the cell to drop to the low level mark. Add the required amount of the 51% solution. Do not fill the cell above the high level mark. If necessary, let the unit operate and allow the level to drop until the rest of the concentrate can be added.

(d) Let the generator operate until the solution level is halfway between the high and low marks, then test the specific gravity of the electrolyte. Make further changes in strength as required.

4.7.4 DECREASING ELECTROLYTE STRENGTH If the specific gravity of electrolyte is above the maximum allowable level of 1.28, the strength can be reduced as follows:

(a) Syphon out enough electrolyte from the cell to bring the solution down to the low level mark.

(b) Add demineralized water to bring the level up to the mid level between high and low marks.

(c) Let the unit run for 10 minutes to allow the solution to mix.

(d) Measure the Specific Gravity of the electrolyte.

(e) If it is still above the maximum value, repeat steps a to d.

4.7.5 ADDING AND REMOVING ELECTROLYTE One way to add electrolyte to the cells is by using the plastic funnel provided with the generator. Remove the hydrogen gas offtake tube and vent pipe and insert the funnel. Observing all the safety rules, slowly pour the electrolyte into the cell.

4.7.5.1 Another method is to place the container with the solution on top of the cubicle and use a syphon to pour the electrolyte into the cell. Extra care must be taken when lifting the container so that the solution will not spill.

4.7.5.2 To remove electrolyte from a cell, place a container on the floor and syphon the solution out. If a syphon is not available, the cell can be removed (reference para. 5.3.11.1) and the electrolyte poured out through the headers. Because the cell is heavy two people are required for this operation.

NOTE : (1) ELECTROLYTE LEVEL ASSUMED TO BE MIDWAY BETWEEN HIGH AND LOW LEVELS WHEN SAMPLE TAKEN.
(2) DO NOT FILL BEYOND HIGH LEVEL - IF NECESSARY, ADD IN MORE THAN ONE LOT.

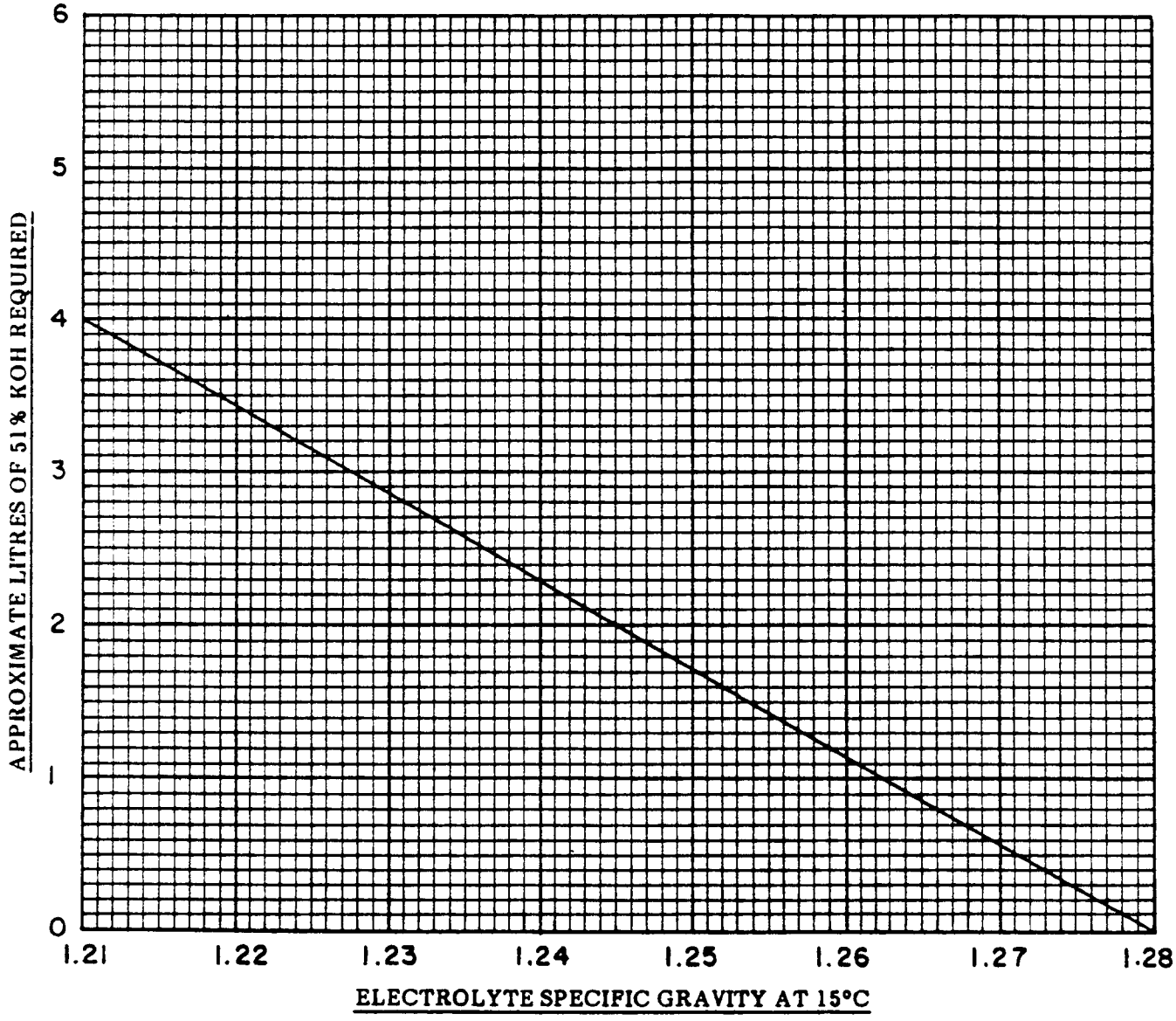



Figure 4-2 Approximate Makeup Electrolyte Required for 250 Ampere Cell

# SECTION 5

# MAINTENANCE

## GENERAL

5.1 This section describes troubleshooting and corrective maintenance procedures for the Hydrogen Generating System. A certain amount of expertise and ability to read schematics is required to accurately analyze problems and trace faults to specific components. This knowledge is acquired through experience and through specialized training. Operators with limited experience should not carry out any extensive maintenance on their own unless they have been authorized to do so by the OIC or by a specialist. This applies especially to electric circuits and components in the cubicle.

## SYSTEM TROUBLESHOOTING

5.2 Before maintenance action can be carried out on a defective component, it is first necessary to isolate the fault. This section describes troubleshooting procedures for some of the circuits within the system.

5.2.1 THE CONTROL ALARM UNIT If the Control Alarm Unit will not energize when start-up procedures in para. 4.1.1 are followed, check the following:

(1) Main Breakers - Ensure that the 120V and 240V circuit breakers at the main panel are turned ON.

(2) Low Pressure Switch - Ensure that switch S10 has not tripped. The unit can not be energized until the switch is reset. If the switch can not be reset because of pressure loss in the line, it has to be bypassed until the pressure is restored. To do this, connect shorting leads between terminal 4 on TB1 and terminal 4 on TB2 inside the electrical cubicle of the Electrolytic Hydrogen Generator. Turn the Control Alarm Unit and Electolytic Hydrogen Generator ON and let the generator operate until the switch can be reset. Disconnect the shorting leads and close the cubicle door.

NOTE

If the gasholder is resting near the bottom, Low Limit switch S15 might be activated. The rectifier will not start until this switch is closed. If necessary, lift the lead weight manually above the switch and start the Electolytic Hydrogen Generator. Release the weight after the gasholder has risen high enough to clear the switch.

(3) Emergency Off Button - Ensure that the 'EMERG. OFF' button S5 is not stuck in the open position.

(4) Fuse F1 - Ensure that this power fuse has not blown. If it has, the fuse holder would glow. Replace as required. If it blows repeatedly, the cause should be investigated and the fault corrected.

(5) Gas Detector System - Ensure that the Warn or Alarm relays have not been triggered. The Gas Detector System has to be reset before the Control Alarm Unit can be activated. To confirm that the fault is in the Gas Detector Circuit, remove fuse F2 on the door of the Control Alarm Unit. If the unit will start without the fuse but not when the fuse is in, the fault is probably in the Gas Detector System. Refer to para. 5.2.2 for corrective action.

(6) Fire Detector System - Ensure that the Fire Detector Circuit has not been activated. This circuit has to be normal before the Control Alarm Unit can be energized. To confirm that the problem is in the Fire Detector Circuit, remove fuse F3 from the door of the Control Alarm Unit. If the unit will start without the fuse but not when the fuse is in, the fault is likely in the Fire Alarm System. Refer to para. 5.2.3 for corrective action.

(7) Wiring - If none of the above correct the fault, check all the wiring in the Control Alarm Unit for broken or loose connections. For this check ensure that the main power breakers are OFF.

(8) Voltage Checks - After steps 1 through 7 have been followed and no apparent fault is found, a more thorough check of the Main Control Circuit can be made. Refer to circuit schematic figure 7-1 and wiring diagram figure 7-2. Proceed as follows:

(a) Turn on the main 120V and 240V breakers.

(b) Turn the 'NORMAL/DISABLE' switch to 'NORMAL' position.

(c) Set a voltmeter on 250 Vac scale. Connect the positive lead to terminal 2 on TB2 and the negative lead to terminal 1 on TB2 inside the Control Alarm Unit. The meter should indicate approximately 120 Vac. If it does not, there is probably something wrong with the power supply. If the main supply is normal, check the voltage between TB2(1) and the following test points;

TB2-1 and the 'S1' side of F1 fuse holder - if no voltage, check F1.

if voltage normal
↓
TB2-1 and K2-7 - if no voltage, check Warn and Alarm relays.

if voltage normal
↓
TB2=1 and K2-1 - if no voltage, check the K2 relay.

if voltage normal
↓
TB2-1 and K1-4 - if no voltage, check connection from K1-4 to K2-1 and S2.

if voltage normal
↓

TB2-1 and K1-3 - PRESS S2 'ENABLE' BUTTON - if no voltage, check S2.

if voltage normal
↓
TB2-1 and TB1-7 - if no voltage check S1 (S1 in 'NORMAL' position).

if voltage normal
↓
TB2-1 and TB1-4 - if no voltage, check S5 and S10 in electrical cubicle of the Electrolytic Hydrogen Generator.

if voltage normal
↓
Check K1

5.2.2 THE GAS DETECTOR/ALARM SYSTEM The gas alarm panel should be powered up at all times except when maintenance is carried out on the system. The green 'PILOT' light is an indication that power is supplied to the unit. Troubleshooting, testing and adjusting procedures for the system are described in this section.

5.2.2.1 The 'PILOT' Light Is Off If the green 'PILOT' light on the Gas Alarm Panel is OFF, check the following:

(a) The Light Bulb - the bulb might be burned out. Press the 'TEST' button. If the meter responds, the bulb has likely burned out. Replace the bulb using procedures in 5.2.2.10.

(b) The Main Breaker - If the meter does not respond in (a), check the 120V breaker which supplies power to the Control Alarm Unit. The breaker should be ON.

(c) Fuse F2 - If the breaker in (b) is ON, check fuse F2 in the Control Alarm Unit. If the fuse has blown, the fuse holder should be glowing. To replace the fuse follow procedures in para. 4.1.3.

5.2.2.2 The Alarm Circuit - The Alarm Circuit should be triggered when the L.E.L. meter indicates 40%. If it does not, proceed with the following adjusting and troubleshooting procedures.

5.2.2.2.1 Adjusting the Alarm Level - proceed as follows:

(a) Turn the 'ZERO' pot adjustment screw slowly clockwise until the 'ALARM' light goes on. The light should go on when the meter indicates 40% L.E.L. If it goes on above 40% proceed to (b). If it goes on below 40% bring the 'ZERO' adjustment back to 0%, press the 'RESET' button and turn the 'ALARM' adjustment slightly clockwise. This sequence should be repeated until a reading equal to or higher than 40% is generated. If the resulting reading is equal to 40% no further action is required. If the reading is higher, proceed to (b).

(b) Turn the 'ZERO' pot until the needle indicates 37-38% L.E.L.

(c) Turn the 'ALARM' pot slowly counterclockwise until the 'ALARM' light goes ON.

(d) Press and hold the 'RESET' button and turn the 'ALARM' pot slowly clockwise until the Alarm Light goes off.

(e) Release the 'RESET' button and turn the 'ZERO' pot clockwise until the 'ALARM' light goes ON. This indicates the new L.E.L. setting of the Alarm Circuit.

(f) If necessary repeat steps (b) to (e) until a 40% Level is obtained.

5.2.2.2.2 Troubleshooting the Alarm Circuit

(1) 'ALARM' Light Doesn't Go ON, meter normal.

(a) Relay Clicks - bulb may be burned out. Replace (para. 5.2.2.10).

(b) Relay Doesn't Click - possible faulty relay, check.

(2) 'ALARM' Light Goes ON at wrong Level - adjust the level (para. 5.2.2.2.1).

(a) Level cannot be adjusted - faulty PC Board, replace (para. 5.2.2.12).

(b) Light stays ON continuously - possible faulty relay, check.

5.2.2.3 The Warn Circuit - The Warn Circuit should be triggered when the L.E.L. meter indicates 20%. If not, proceed with the following adjusting and troubleshooting procedures.

5.2.2.3.1 Adjusting the Warn Level - proceed as follows:

(a) Turn the 'ZERO' pot adjustment screw slowly clockwise until the 'WARN' light goes ON. The light should go ON when the meter indicates 20% L.E.L. If it goes ON above 20% proceed to (b). If it goes ON below 20% bring the 'ZERO' adjustment back to 0%, press the 'RESET' button and turn the 'WARN' adjustment slightly clockwise. This sequence should be repeated until a reading equal to or higher than 20% is generated. If the resulting reading is equal to 20%, no further action is required. If the reading is higher, proceed to (b).

(b) Turn the 'ZERO' pot until the needle indicates 17-18% L.E.L.

(c) Turn the 'WARN' pot slowly counterclockwise until the 'WARN' light goes ON.

(d) Press and hold the 'RESET' button and turn the 'WARN' pot slowly clockwise until the 'WARN' Light goes OFF.

(e) Release the 'RESET' button and turn the 'ZERO' pot clockwise until the 'WARN' light goes ON. This indicates the new L.E.L. setting of the Warn Circuit.

(f) If necessary repeat steps (b) to (e) until a 20% level is obtained.

5.2.2.3.2 Troubleshooting the Warn Circuit

(1) 'WARN' Light Doesn't Go ON, meter normal.

(a) Relay Clicks - may be bulb burned out, replace (para. 5.2.2.10).

(b) Relay Doesn't Click - possible faulty relay, check.

(2) 'WARN' Light Goes ON at wrong level - adjust the warn level (para. 5.2.2.3.1).

(a) Level can not be adjusted - faulty PC Board, replace (para. 5.2.2.12).

(b) Light stays on continuously - may be faulty relay, check.

5.2.2.4 The Fail Circuit - A triggering of the 'FAIL' Light is an indication of a failure in the Detector Circuit. To test and troubleshoot the Fail Circuit proceed as follows.

5.2.2.4.1 Testing The Fail Circuit - the circuit can be tested in three ways:

Test 1

(a) Turn the 'ZERO' pot counterclockwise for a reading of 8-10% below zero. The Fail Relay K3 should click and the light should go ON.

(b) Adjust the 'ZERO' pot until the meter indicates zero. The relay should click and the light should go out.

Test 2

(a) Disconnect any one detector wire from the terminal strip behind the PCB (A1, C1 or R1). The Fail relay K3 should click and the light should go ON.

(b) Reconnect the wire to the terminal. The relay should click and the light should go out.

Test 3

(a) Remove the sensor from the Detector Head. The fail relay should click and the 'FAIL' light should go ON.

(b) Replace the sensor. The relay should click and the light should go out.

5.2.2.4.2 Troubleshooting the Fail Circuit

(1) 'FAIL' Light Goes ON:

(a) Replace the sensor (para. 5.2.2.11).

(b) With power OFF, check the detector wiring for good connections at the Detector Head junction box and on the terminal strip behind the PC Board.

(c) Replace the relay.

(d) Replace the PCB (para. 5.2.2.12).

(2) 'FAIL' Light Doesn't Go ON during tests:

(a) Replace the bulb if the relay clicks (para. 5.2.2.10).

(b) Replace the Relay.

(c) Replace the PCB (para. 5.2.2.12).

5.2.2.5 The Test Circuit (Range) - When the 'WARN/TEST' button is pressed, the meter should deflect to 100%. If it does not, proceed with the following adjusting and troubleshooting procedures.

5.2.2.5.1 Adjusting the Test Circuit - To adjust the test circuit proceed as follows:

(a) Press and hold the 'WARN/TEST' button.

(b) Adjust the 'RANGE' pot on the PC Board for 100% deflection on the meter.

NOTE

When the 'TEST' button is pressed and held for a few seconds, the Warn and Alarm relays should be triggered and the lights should go ON. After the 'TEST' button is released and the 'RESET' button is pressed, the 'WARN' and 'ALARM' lights should go out.

The 'RANGE' setting is affected by the 'GAIN' adjustment. If the 'GAIN' setting is altered, the 'RANGE' should be readjusted.

5.2.2.5.2 Troubleshooting the Test Circuit

(1) The Meter does not respond when the 'TEST' button is pressed. Check the 'TEST' button as follows:

(a) Turn the power to the unit OFF.

(b) Connect an ohmmeter across terminals 3 and 6 on the back of the switch. The numbers are on the side of the body.

(c) Press the 'TEST' button. The meter indication should jump from infinite to zero as the button is pressed. If it does not, the switch may be defective and would then have to be replaced.

(2) The Meter is erratic, fluctuates or cannot be set to full scale. The problem could be with the PCB and the Board should be replaced.

5.2.2.6 Calibration of Gas Detector - The Gas Detector System is calibrated each month. In addition when the Gain has been tampered with or a new sensor or PC Board has been installed, full calibration procedures should be carried out. Two people are required to perform the calibration, one at the sensor and one at the PC Board. Proceed as follows:

(a) Turn OFF the power to the Hydrogen Generator.

(b) Ensure that the atmosphere around the detector is free of hydrogen by opening the doors to the outside and thoroughly ventilating the room.

(c) Ensure that the meter indicates zero. Carry out the electrical zero adjustment if necessary (para. 5.2.2.8).

(d) One person should assemble the Calibration Test Kit and place the Sample Cup over the shield assembly.

(e) Slowly release the test gas from the cylinder by turning the regulator knob clockwise. The flow rate should be between 5 and 8 psi.

NOTE

At this flow rate it should take between 30 and 60 seconds to complete the test. To conserve the gas shut off the flow as soon as the test is complete.

(f) The second person should be watching the meter. Let the meter reading stabilize. Then, if necessary, adjust the 'GAIN' potentiometer on the circuit board so that the meter reading matches the '%L.E.L.' value printed on the test gas cylinder.

NOTE

The 'RANGE' setting is affected by the 'GAIN' adjustment. If the 'GAIN' setting is altered, the 'RANGE' should be readjusted (para. 5.2.2.5).

(g) Close the regulator valve and remove the sample cup. The needle should slowly return to zero.

(h) Reset the Alarm System.

(i) Disassemble the Gas Kit and replace it in the carrying case. Do not leave the regulator attached to the cylinder as leakage will occur.

5.2.2.6.1 Calibration Problems

(a) If the meter reads below zero when the test gas is applied, check the detector wiring for reversal of A&R wires.

(b) If the 'GAIN' cannot be adjusted to the correct level or if the meter does not stabilize when gas is applied, replace the sensor. If the problem persists, replace the PC Board.

5.2.2.7 **Setting Detector Operating Voltage** - During initial system installation and when new reference values for the operating voltage are required, the voltage has to be set at the detector. Two people are required to perform this operation, one at the detector and one at the control panel. The equipment needed are a test socket adapter and a DC Voltmeter with a 0-10 volt range and a minimum accuracy of +/- 2%. Proceed as follows:

(a) Turn OFF the power to the Electrolytic Hydrogen Generator and ensure that the room is well ventilated.

(b) Turn OFF the power to the Gas Control Panel. The 'PILOT' Light should go off.

(c) Loosen the set screw which secures the detector shield to the detector body and unscrew the shield assembly.

(d) Remove the sensor from the socket.

(e) Plug the sensor into the test socket adapter and plug the adapter into the detector.

(f) Set the voltmeter to the 10 Vdc range and clip the '+' lead of the meter to terminal 'A' and '_' lead to terminal 'R' of the adapter. See figure 5-1.

(g) Turn ON the power to the Control Panel.

(h) Using a small flat screwdriver, adjust the 'VOLT' potentiometer on the Printed Circuit Board to obtain a reading of 6.0 Vdc on the voltmeter. Turning the adjustment clockwise will increase the voltage.

(i) With the voltmeter take a measurement across the red and black test points under the 'VOLT' potentiometer and record the value in the Log Book. This will be the reference value used during monthly checks.

(j) Turn the power OFF. Remove the adapter and replace the sensor element.

(k) Reassemble the detector.

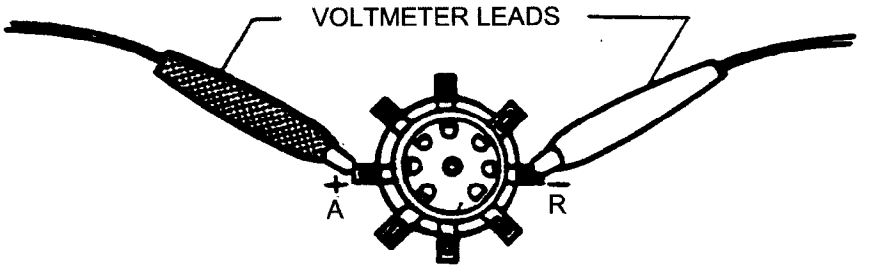



Figure 5-1 Reading Adaptor Voltage

(1) Turn the power ON and reactivate the system.

5.2.2.8 Adjusting the Electrical Zero - The 'ZERO' potentiometer on the PCB is used to adjust the electrical zero of the meter. Proceed as follows:

(a) Turn OFF the power to the Electolytic Hydrogen Generator.

(b) Ensure that the atmosphere around the detector is free of hydrogen by opening the doors to the outside and thoroughly ventilating the room.

(c) With the power to the Gas Alarm Panel ON, adjust the 'ZERO' potentiometer until the meter indicates zero.

5.2.2.8.1 Possible Problems with the electrical zero adjustment:

(1) Faulty Sensor - if the meter cannot be adjusted to zero or if the needle fluctuates, the sensor could be defective. Replace with a spare (para. 5.2.2.11).

(2) Faulty Wiring - if the meter pointer jumps off scale, check the wiring connections at the detector junction box and at the terminal strip behind the PCB. This is to be done with the power OFF. Ensure that the connections are tight and that there are no shorts.

(3) Detector Voltage - check the detector voltage to ensure that values are correct (para. 4.2.5.1). Adjust if necessary.

(4) The Printed Circuit Board - if all of the above are normal, replace the PCB (para. 5.2.2.12).

5.2.2.9 Adjusting the Meter Zero - When the power to the gas alarm panel is OFF, the L.E.L. meter should indicate zero. If the pointer is not indicating correctly, the meter can be adjusted as follows. (If the meter cannot be adjusted, replace it with a new one, see para. 5.2.2.13.2):

(a) Turn OFF the power to the panel.

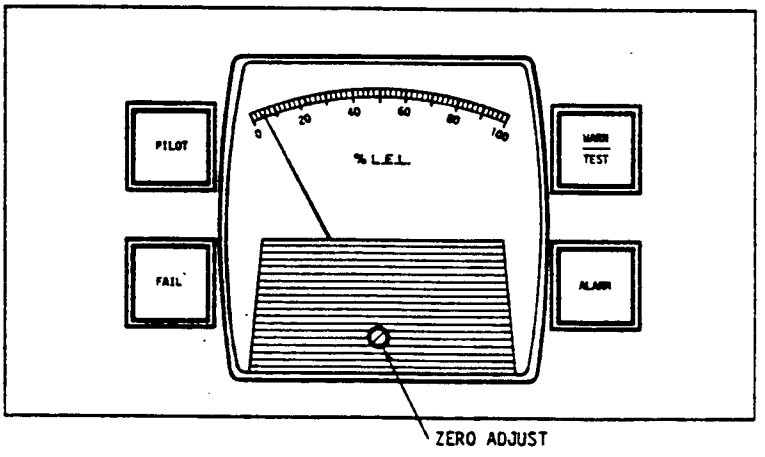



Figure 5-2 '%L.E.L.' Meter Zero Adjustment

(b) With a small screwdriver, adjust the screw under the meter until it indicates zero. Refer to figure 5-2.

5.2.2.10 Replacing the Indicator Lamp

(a) Turn the power to the Gas Alarm Panel OFF.

(b) Grasp the plastic lamp cover with fingers and pull out. The lamp assembly will come out with the cover.

(c) Insert a fingernail or a thin blade under the end flange of the lamp and pry the lamp out of the socket.

(d) Install a new lamp and replace the assembly into the panel.

5.2.2.11 Replacing the Sensor - Sensor life is governed by amount of exposure to hydrogen. Under ideal conditions the sensor should be good up to 5 years. In actuality its life is much shorter. An indication of a failing sensor is slow response to test gas, erratic movement of the meter pointer, and inability to set the gain or the electrical zero. To replace sensor proceed as follows:

(a) Turn OFF the power to the control panel.

(b) Loosen the set screw on the side of the shield assembly.

(c) Unscrew the shield assembly from the detector body.

(d) Hold the detector body with one hand and pull the sensor out with the other.

(e) Install a new sensor ensuring that the pins in the sensor align with the holes in the detector.

(f) Replace the shield assembly by screwing it onto the detector body.

(g) Turn on the power and perform system calibration (para. 5.2.2.6).

5.2.2.11.1 Testing the Sensor - a sensor can be checked with an ohmmeter by measuring the resistance of the active and reference elements. This is done across sensor pins 1 and 3, and pins 5 and 7 using a low range on the meter. The resistance across these pins should be 7 ±1 Ω. See figure 5-3. If the resistance values are outside the limits the sensor should be replaced.

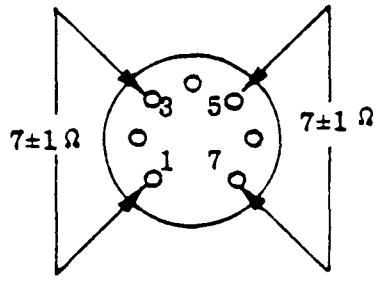



Figure 5-3 Testing Sensor

5.2.2.12 The Printed Circuit Board - Lack of response, erratic meter movement, or failure in the Fail, Warn or Alarm circuits could be an indication of a defective PCB. First the sensor and the affected circuit should be checked out (para. 5.2.2). As a last resort the PCB can be removed, refer to para 5.2.2.12.1.

5.2.2.12.1 Removing the Printed Circuit Board

(a) Switch OFF the power to the Gas Alarm Panel.

(b) Open the cabinet door and swing open the front panel.

(c) Pull the PCB from the stand off posts. If the board has been pushed too hard onto the posts, it may be necessary to squeeze the base of the posts either with fingers or with needle nose pliers to release the board from the locked position.

(e) Pull the top and bottom connectors off the PCB.

(f) Pack the board well and ship out for repairs. If necessary, bypass the gas detection system (para. 4.2.2).

5.2.2.12.2 Installing the Printed Circuit Board

(a) Switch OFF the power to the Gas Alarm Panel.

(b) Fit the top and bottom connectors over the PCB contacts.

**CAUTION**

Do not reverse the connectors. Usually they are marked with a red dot on the front. Ensure that the PCB is oriented with the potentiometers on top.

(c) Place the PCB so that the 4 holes fit over the standoffs and push it down. Some manoeuvring may be necessary in aligning and in fitting the relays under the hinges of the panel.

(d) Turn ON the power.

(e) Carry out full system calibration and check all the adjustments and levels.

5.2.2.13 L.E.L. Meter - Lack of meter response can be an indication of a defective meter. For testing and replacing the meter, proceed as follows.

5.2.2.13.1 Testing the Meter - The meter can be tested by connecting a ONE MILLIAMP source across the meter terminals. Proceed as follows:

(a) Turn OFF the power to the Gas Alarm Panel.

(b) Disconnect one of the wires from the meter terminals.

(c) Connect a digital multimeter, set on the highest resistance scale, across the meter terminals (Red lead to positive terminal). Note the indication on the meter under test. It may not move yet. Work your way down on the resistance scale a step at a time. Don't peg the meter and don't go below the 2000 Ω scale. As you work your way down you should see an indication on the multimeter under test. If there is no response then it should be replaced.

(d) A deflection is an indication that the meter is working properly. A setting on a higher resistance scale will result in a smaller deflection. If the meter itself is serviceable but there is no response from the control panel, the PC Board is probably defective and should be replaced. If the meter is defective, refer to para. 5.2.2.13.2.

5.2.2.13.2 Replacing the Meter - proceed as follows:

(a) Turn OFF the power to the Gas Alarm Panel.

(b) Unscrew the nuts from the terminals on the back of the meter.

(c) Remove the two leads from the terminals and mark them as positive and negative.

(d) Unscrew the 3 small retaining nuts which hold the meter to the panel.

(e) Pull out the meter and replace it with the new one. Ensure that the leads are connected to the correct terminals.

(f) Carry out meter zero and electrical zero adjustments.

5.2.3 THE FIRE ALARM SYSTEM Two situations are an indication of a fault within the Fire Alarm system. The first is when the alarm trips without actual alarm conditions existing. The second is when the system does not activate when the 'TEST' button is pressed. In either case, the fault must be found and corrected.

5.2.3.1 The Fire Alarm Trips If the fire alarm trips during normal conditions check the following:

(1) The Sensor - Disconnect the black and white leads from terminals 1 and 2 on TB3 in the Control Alarm Unit. With an ohmmeter check for continuity across these leads. Under normal conditions the sensor contact should be open. If it is closed, then either there is a short somewhere in the connections or the detector is faulty. Repeat the test with the meter at the junction box beside the sensor. If necessary, replace the faulty sensor (see para. 5.2.3.3).

(2) The K2 Relay - This relay controls the contacts in the Fire Alarm system. If the 'ALARM' light is ON, it means that the K2 coil is energized either through the sensor contact, the S3 'TEST' button, or through the K2 contact. Check the S3 pushbutton and/or K2 as follows:

(a) Switch OFF the 120 Volt power supply.

(b) Disconnect the red leads from the two switch terminals.

(c) With an ohmmeter check across the terminals for continuity. The contact should be open.

(d) With the meter leads still connected, press S3. The meter should indicate continuity. If the switch is faulty, replace.

(e) Check the K2 contacts. Pull out the K2 relay from the Control Alarm Unit. With an ohmmeter check the contacts as follows;

- contact between terminals 5 and 8 should be open
- contact between terminals 4 and 7 should be open
- contact between terminals 1 and 7 should be closed

(f) If the contacts are not as indicated above, replace the K2 relay.

5.2.3.2 The Fire Alarm Does Not Go On If the Fire Alarm does not go on when the 'TEST' button S3 is pressed, check the following:

(a) If both the Gas Detector and Fire Alarm Systems are off, then the problem is likely with the 120 Volt power supply. Check the breaker to ensure that it is ON.

(b) Fuse F3 - check and replace if faulty.

(c) S3 'TEST' button - check as per para. 5.2.3.1 (2), steps (a) to (d).

(d) The K2 Relay - check as per para. 5.2.3.1 (2), steps (e) and (f); and in addition, check the K2 coil by unplugging the relay and checking for resistance across terminals A and B with ohmmeter. If there is a break in the coil, replace the relay.

5.2.3.3 Replacing A Defective Fire Sensor If a fire sensor is found to be defective, it should not be removed until a replacement unit is received. If necessary, the alarm system can be bypassed by removing fuse F3 from the circuit. This way the generator can be kept operational until a replacement sensor arrives.

5.2.3.3.1 If two sensors are wired into the system, the defective one can be disconnected at the junction box, and the lead ends taped up with electrical tape. The good sensor will remain connected in the system.

5.2.3.3.2 As soon as the new sensor is received, it should be installed and the Fire Alarm system reactivated. To install the new sensor proceed as follows:

(a) Turn OFF the 120 Volt power supply breaker.

(b) Remove the cover from the junction box at the sensor.

(c) Disconnect the sensor leads at the junction box.

(d) Unscrew the sensor from the junction box. On the explosion proof box, the sensor screws directly into the housing. On the regular box, a locknut inside the box has to be unscrewed. A bushing against which the locknut presses, can then be pulled off the threaded end of the sensor, and the sensor can be pulled out of the box together with the leads.

(e) Install the new sensor.

5.2.4 THE RECTIFIER CONTROL CIRCUIT If the Rectifier does not start when the 'RECTIFIER START' button is pressed, check the following:

(1) Control Alarm Unit - Ensure that this unit is enabled. The Electrolytic Hydrogen Generator will not start until the Control Alarm Unit is energized. If the unit will not enable, follow troubleshooting procedures in para. 5.2.1.

(2) Breakers - Ensure that the breakers inside the cubicle are switched ON.

(3) Time Delay - Ensure that sufficient time has gone by to activate the Time Delay relay.

(4) Fan Motor - Ensure that the Fan Motor is running. The Time Delay system can not be activated unless the fan is working.

(5) The P.D.S. - Ensure that the Pressure Differential switch is reset.

(6) Switch S15 - Ensure that the Low Limit switch S15 is not being tripped by the weight. The rectifier will not start if the switch is activated. If necessary, manually lift the weight until sufficient pressure has built up inside the bell for the weight to clear the switch.

(7) K5 Relay - Ensure that the overload relay K5 has not been activated. If it has, the red light should be ON.

(8) K1 Overload - Ensure that the overload mechanism for the K1 contactor has not tripped. Press the two overload resets on the side of K1.

(9) Time Delay System - Check the time delay system by opening the door and pulling out the maintenance switch. Press the 'RECTIFIER START' button. If the unit now starts, the problem is in the Time Delay System. Check the following components:

(a) The Wind Switch - Ensure that the switch assembly moves freely up and down in the hinges, and that the wires are flexible and do not catch on the frame. The plastic sail should rest on the bottom of the bracket, and a very slight pressure should be sufficient to move it up. If necessary, slide the glass bulb back in the bracket until the proper movement is obtained.

(b) Time Delay Relay - Replace the K3 relay with a spare. Try starting the Rectifier with the door closed. If it starts after approximately 60 seconds, the relay was defective.

(10) Voltage Checks - If the system does not start with the maintenance switch pulled out, a more thorough check of the circuit has to be made to isolate the fault. Proceed as follows:

(a) Pull out the maintenance switch.

(b) Set a voltmeter on 250 Vac scale.

(c) Check the voltage between TB1-12 and TB1-14. It should read approximately 120 Vac. If there is no voltage, there may be something wrong with the main power supply from the Control Alarm Unit or with the neutral supply from the main panel.

(d) Check the voltage between the following Test Points:

↓

TB1-12 and K3-8 - if no voltage, check CB2 and CB4.

if voltage normal

↓

TB1-12 and K3-6 - if no voltage, check maintenance switch S9.

if voltage normal

↓

TB1-12 and TB2-40 - if no voltage, check P.D.S. S11 and L.L. Switch S15.

if voltage normal

↓

TB1-12 and TB2-15 - if no voltage, check S2.

if voltage normal

↓

TB1-12 and TB2-11 - PRESS S1 - if no voltage, check S1.

if voltage normal

↓

TB1-12 and TB2-19 - if no voltage, check contact K5a of relay K5.

if voltage normal

↓

TB1-12 and TB2-1 - if no voltage, check coil and overload contacts of K1.

5.2.5 CURRENT AND VOLTAGE CONTROL PROBLEMS Any problems related to current and voltage fluctuations or lack of control can usually be traced to the Regulator, Control Module, or faulty wiring. A spare regulator is kept on each station so a defective one can be replaced as required. If a fault is traced to the Control Module the regional office should be advised so that arrangements for shipment of a replacement module can be made. To isolate the fault check the following:

5.2.5.1 The TC-2 Regulator - Switch the power OFF and replace the regulator with a spare. Turn the power back on and allow the unit to warm up. If the problem is resolved, the regulator was defective and should be sent out for repairs.

5.2.5.2 Loose Connections - Switch OFF the power to the generator at the Control/Alarm Unit. Tighten all the connections on the components and terminal boards in the lower and upper compartments of the cubicle including the transformers, the heat sink and the buss bars.

5.2.5.3 Feedback Signal From The Current Transformer - This signal represents the actual line current. It is fed to the Control Module and compared against a reference signal in order to compensate the system for any fluctuations in the main line. The feedback voltage is created across the long load resistor located beside the round current transformer in the lower cubicle. It can be checked as follows:

(a) Connect the leads of a low scale DC voltmeter across TB2-24 and 25.

(b) Set the operating current at 230 amps.

(c) The normal voltage is between 1 and 1.5 Vdc. If the reading is outside these limits the problem could be either with the Current Transformer or the Bridge Rectifier. A spare bridge is kept on station.

**WARNING**

An open circuit in the Bridge Rectifier could result in a buildup of voltage and arcing. Ensure that the power is 'OFF' before handling any of the components in the Current Transformer/Bridge Rectifier Circuit.

5.2.5.4 Regulator Output - The output from the regulator controls a FET which in turn controls the DC current to the Saturable Reactor. This output can be measured across pins 9 and 11 on TC-2 or more easily across the white and white/yellow wires which connect to the small terminal block on the black heat sink on the Control Module. The voltage across these wires should increase from 0-8.4 Vdc as the operational current is adjusted from 0-230 amps. If the voltage does not increase, the regulator may be faulty and should be replaced.

5.2.5.5 Control Module Output - The output from the Control Module is applied to the Saturable Reactor (L1). It can be measured across terminals 23 and 26 on TB2. At 230 amps the reading should be approximately 42 Vdc. If the reading is too low or too high it is an indication that there is a fault in the Control Module. Advise the regional office and arrange for a replacement unit.

5.2.5.6 Main Diodes, Fuses or Circuitry - If the amperage as indicated on the cubicle ammeter drops substantially from the value of normal control potentiometer setting, it would probably indicate that either one of the fuses which protect the rectifier diodes has blown, an open circuit diode, or a high resistance connection between the transformer and the cells. With the main power OFF, proceed as follows:

5.2.5.6.1 Fuses Disconnect one of the leads from each of the large fuses on the main heat sink. With an ohmmeter check for continuity through the fuse. If the fuse has blown, check diodes (para. 5.2.5.6.2) and replace the fuse. If it blows again, investigate the cause.

5.2.5.6.2 Diodes Disconnect the lead from either end of the diodes. Connect an ohmmeter across the diode then reverse the leads. The ohmmeter should indicate a very high resistance in one direction and a very low resistance in the other. If it shows either a very high or a very low resistance in both directions, the diode should be replaced.

5.2.5.6.3 High Resistance Connection Use ohmmeter to isolate the area of high resistance between transformer and cells.

5.2.6 THE COMPRESSOR CONTROL CIRCUIT If the Compressor Circuit can not be energized when either the Upper Limit Switch S13 or the 'COMPRESSOR START' button is pushed, check the following:

(1) 'COMPRESSOR INLET' Switch - Ensure that S16 is in the correct position. The handle of the valve should be pressing against the switch actuator.

(2) Low Limit Switch S14 - Ensure that the lead weight is above S14, and that the cable is not pressing against the roller arm causing it to trip. Manually press the arm several times to ensure that it is switching off and on.

(3) High Pressure Switch - Ensure that the HPS has not been activated. If it has, the rectifier will be in idle mode and the compressor will not start.

(4) K2 Overload - Ensure that the overload mechanism for the K2 contactor has not tripped. Press the two overload resets on the side of K2.

(5) Voltage Checks - If none of the preceeding solve the problem, a more thorough check of the circuit has to be made to isolate the fault. Proceed as follows:

(a) Pull out the maintenance switch and start the rectifier.

(b) Set a voltmeter on the 250 Vac scale.

(c) Check the voltage between TB1-11 and TB2-31. It should read approximately 120 Vac.

(d) Check the voltage between the following test points;

TB1-11 and TB2-17 - if no voltage, check the H.P.S. (S12).
if voltage normal
↓
TB1-11 and TB2-8 - if no voltage, check S4.
if voltage normal
↓
TB1-11 and TB2-12 - PRESS S3 - if no voltage, check S3.
PRESS S13 - if no voltage, check S13.
if voltage normal
↓
TB1-11 and TB2-32 - if no voltage, check S14 and S16.
if voltage normal
↓
TB1-11 and TB2-2 - if no voltage, check overload of K2 and K2 coil.

(6) Other Possible Problems include a defective K2 contactor or a defective motor. To check or replace the motor refer to para. 5.3.10.

5.2.7 COMPRESSION PROBLEMS If there are problems in getting the tank pressure to build up to 100 psi the problem could be with one of the following:

(a) Leak in the High Pressure line - double check all the fittings and connections in the High Pressure line. Tighten or replace as required.

(b) Leak in the Solenoid valve - it is possible that the gas could be leaking out through the Solenoid valve to the vent. Refer to para. 5.3.5 for testing and repair of the valve.

(c) Defective Compressor Head - the discharge or suction valves in the Compressor Head may become clogged or worn resulting in poor compression. Refer to para. 5.3.9 for testing and replacement procedures.

5.2.8 THE REMOTE INDICATING LIGHTS If one or all of the remote indicating lights go out while all the Electolytic Hydrogen Generator circuits are normal, the problem must be found and corrective action taken.

5.2.8.1 All Three Lights Go Out - If all three of the remote lights go out, the problem is likely with the wire or component that is common to all three lights. Check the following:

5.2.8.1.1 The Common Wire - Check the wiring at terminal TB1-5 inside the Control Alarm Unit, and between TB1-5 inside the cubicle and transformer T2. Ensure that the wire is not broken and the connection is tight.

5.2.8.1.2 Transformer T2 - Check as follows:

(a) Check the voltage between terminals TB1-3 and TB1-5 in the Control Alarm Unit. This is the output of transformer T2 and should read approximately 12 Vac.

(b) If there is no voltage here, take a reading between TB1-3 and TB1-5 inside the cubicle. If the voltage is normal in the cubicle but not at the Control Alarm Unit, there is probably a break in one of the lines between these units.

(c) If there is no voltage in the cubicle, check the input to the transformer at terminals TB2-40 and TB1-11. It should be approximately 120 Vac.

(d) If the input is normal but there is no output, the transformer may be defective and should be replaced.

(e) If there is no input, then the lines to the transformer must be traced back to source until the fault is found.

5.2.8.2 Only One Light Goes Out - If only one light goes out, the components within the circuit which energize that light should be checked as follows:

5.2.8.2.1 The Light Bulb - Check whether the bulb has burned out by replacing with a spare. Check the bulb by measuring for continuity across the bulb element.

5.2.8.2.2 The Voltage - Check as follows:

(a) Check the voltage across the two wires which connect to the lamp socket. The reading should be approximately 12 Vac.

(b) If there is no voltage, take a measurement between the common terminal and the respective lamp terminal on TB1 in the Control Alarm Unit.

- Terminal 5 is common
- Terminal 1 is Rectifier Light
- Terminal 2 is Compressor Normal Light
- Terminal 6 is Room Temperature Light

(c) If the voltage is normal at TB1 but not at the lights, the fault may be in the wires between the Control Alarm Unit and the lights.

(d) Confirm this by turning off the power, shorting the leads at either end and measuring for continuity at the other end.

(e) If there is no continuity, then one of the wires could be broken and must be replaced.

5.2.8.2.3 The Cable - If there is no voltage on TB1 in the Control Alarm Unit, proceed as follows:

(a) Check across the same terminals but on TB1 in the electrical cubicle of the Electolytic Hydrogen Generator. If the voltage is normal in the cubicle but not at the Control Alarm Unit, then the problem may be in the cable between these two units.

(b) To confirm this, turn off the power and short out the respective leads at either end of the cable. Check for continuity across the terminals at the other end of the cable. If there is no continuity, then there is likely a break in the line.

(c) Wires at terminals 8, 9 and 10 on the ten conductor cable are spares and can be used for replacing broken ones. Disconnect the faulty wire at both ends of the cable and connect one of the spares in its place.

5.2.8.2.4 The Contacts - Check the contacts of the devices which energize the respective lights to see if they are operating normally.

(1) Rectifier Contact K1b - This contact operates the Rectifier Light. To check its operation proceed as follows:

(a) Turn off the power at the main breaker.

(b) Disconnect leads 1 and 3 of the ten conductor cable from TB1 inside the cubicle.

(c) Check for continuity across terminals 1 and 3. With the power off, K1 should be deenergized and the K1b contact should be open.

(d) With the ohmmeter still connected, manually push upwards the bottom of K1. The contact should close and the meter should indicate continuity.

(e) If it does not, check all the wiring connections and if necessary, replace the K1 contactor.

(2) Room Temperature Contact - This contact is controlled by thermostat S7.

(a) Check the setting on the dial of the thermostat. It should be set at 40°F. If the temperature at the sensor beside the gasholder is above 40°F then the thermostat contact should be closed.

(b) To check this, turn the power OFF.

(c) Disconnect the leads on the left side of terminal 33 on TB2 and the top of terminal 6 on TB1 inside the cubicle.

(d) Connect an ohmmeter across these two leads. If there is no continuity, turn the thermostat adjust screw clockwise. If the contact remains open, the thermostat is likely defective and should be replaced. Refer to figure 6-20.

(e) If the contact closes when the adjust screw is backed off, the adjustment might be out of alignment with the dial.

(3) Compressor Circuit Contacts - Two contacts in parallel control the compressor normal light. Contact K4b on the High Pressure Switch Relay, and the Upper Limit Switch S17. In operational mode S17 is closed and the circuit to the lights is complete. In idle mode the bell rises to the top and trips S17 causing it to open. However, when the system switches into idle, contact K4b closes so that the circuit to the light remains complete. If the compressor normal light goes out during operational mode and the generator is working normally, it is likely that switch S17 is faulty. Check as follows:

(a) Ensure that the cable supporting the weight which activates the limit switches is not pushing against the roller arm of S17 causing it to trip. Manually press the arm to see if the switch is working properly.

(b) Check the operation of the microswitch.

(i) With power off remove the cover from TB5 and disconnect the switch leads from terminals 3 and 13.

(ii) Check for continuity across these leads. The switch is connected in the normally closed position therefore the meter should show continuity.

(iii) Manually press the roller arm. The continuity should be broken.

(iv) If the switch is not operating properly, refer to para. 5.3.8 for corrective action.

(c) If the compressor light goes out during idle mode and the unit is operating normally, the problem could be with relay K4.

(i) Pull out the K4 relay and measure for continuity across pins 1 and 7. The contact should be closed. If it is open, the relay is likely faulty and should be replaced.

(ii) If the relay contact is closed, check for loose or broken wires between K4 and TB1.

## COMPONENT MAINTENANCE

5.3 This section covers the repair and replacement procedures for the components in the Hydrogen Generating System.

5.3.1 WHITEY TOGGLE VALVE Whitey toggle valves are used on the storage tank inlet line, blowdown, and vent lines. A ninety degree movement of the handle opens the valve to full flow. For a momentary opening as during blowdown of high pressure lines, the handle can be pressed down with a hand momentarily and released. This will permit a quick release of gas and the spring loaded handle will return to its original position.

5.3.1.1 Whitey Valve Maintenance - Maintenance consists of cleaning or replacement of valve stem and 0-ring. The teflon tip on the stem can wear out after extensive use resulting in improper sealing and leakage. For examination and replacement of parts, disassemble the valve as follows:

(a) With the handle in the normally closed position so that the spring is not under tension, push out the pin which attaches the handle to the stem. This can be done with a small pick, nail, or Allen key.

(b) Remove the handle.

(c) Unscrew the nut which attaches the stem assembly to the valve body.

(d) Pull the whole stem assembly out of the valve.

(e) Remove the stem and 0-ring and examine for wear.

(f) The teflon tip of the stem should be clean and show little wear. The 0-ring should be clean and flexible. Replace as required.

5.3.1.2 Assembly of Whitey Valve - To put the valve back together proceed as follows:

(a) Place the stem with the 0-ring and spring in the valve body.

(b) Fit the stem retaining nut over the stem and screw into the valve. This compresses the spring and makes the end of the stem stick out so that it is easier to attach the handle.

(c) Fit the plastic seal over the end of the stem.

(d) Align the holes in the handle with the holes in the stem and push the retaining pin into place.

5.3.2 WHITEY BALL VALVE Several Whitey Ball Valves are used in the gas flow system. Although these valves vary in sizes, their operation and assembly is basically the same.

5.3.2.1 No field repairs are carried out on the ball valves. The teflon packing in the valve body can only be replaced in the shop.

5.3.2.2 If a leak develops around the valve stem, minor adjustments can be made as follows:

NOTE

Make small adjustments only.

(a) Loosen the Allen screw which secures the handle to the stem.

(b) Pull the handle off the stem.

(c) On the small valve, insert the tips of needle nose pliers into the two holes in the top of the packing bolt and tighten clockwise. On the large valve, the packing bolt can be tightened with an adjustable wrench.

(d) This action will press the support ring against the stem packing and the leak might be stopped. If the packing bolt is as tight as it will go and the valve continues to leak, the whole valve will have to be replaced.

5.3.3 NUPRO CHECK VALVE Three Nupro Check Valves are used in the gas flow system. One is used in the high pressure line, one in the P.D.S. line and one in the compressor crankcase vent line. The spring is taken out of the valve in the crankcase line because low line pressure is involved. The weight of the plunger itself is sufficient to prevent reverse flow of gas.

5.3.3.1 Nupro Check Valve Maintenance - No regular maintenance is performed on the valves, however after extended use, problems can develop. Dirt accumulation and loss of elasticity in the spring will result in improper sealing and leakage. Maintenance consists of cleaning and replacement of spring and 0-ring. To remove and disassemble the valve, proceed as follows:

(a) Reduce the gas pressure in the line.

(b) Loosen the swagelok nuts on the ends of the valve and remove one of the sections of stainless steel tubing connected to it.

(c) Remove the valve from the line.

(d) To disassemble the valve, place the hex nut of the outer valve body in a vice and unscrew the hex nut of the inner body. The inner parts of the valve will be exposed.

(e) Remove and examine the spring and 0-ring. Replace if dirty or worn.

(f) Clean the plunger and the inside of the valve body.

(g) Reassemble the valve and put back into the system. Ensure that the valve is oriented in the right direction. The arrow on the outside of the body should point in the direction of gas flow.

5.3.3.2 Testing the Operation of the High Pressure Nupro Check Valve The High Pressure Check Valve can be tested in the line as follows:

(a) Close the tank filling valve V-7.

(b) Start the compressor and build up the pressure in the line until the High Pressure Switch is activated.

(c) Note the reading at the High Pressure Line Gauge.

(d) Press the solenoid activating limit switch S13 to reduce pressure on one side of the check valve.

(e) Observe the gauge for any drop in pressure. The reading should remain the same. If there is a drop in pressure, it is an indication that gas is leaking through the valve.

5.3.3.3 Testing the Operation of the P.D.S. Nupro Check Valve The P.D.S. Check Valve can be tested in the line as follows:

(a) Close the P.D.S. Reset Valve V-6 and the tank inlet valve V-8.

(b) Open the tank filling valve V-7.

(c) Start the compressor and build up the pressure in the line until the High Pressure Switch is activated.

(d) Close Valve V-7 and note the reading at the P.D.S. Pressure Gauge. Reduce the pressure in the line by opening the balloon filling valves.

(e) Observe the gauge for any drop in pressure. The reading should remain the same. If there is a drop in pressure, it is an indication that the valve is leaking. It is also possible for the gas to leak through the PDS reset valve therefore both valves should be checked.

5.3.4 THE PULSATION DAMPENER An Ashcroft Pulsation Dampener is connected between the high pressure line, and the high pressure switch and gauge. The purpose of the dampener is to throttle the pressure pulsations caused by the compressor. If the throttling effect diminishes or if the pressure fluctuations are jerky or erratic, the dampener might be clogged or rusted. It can be taken apart and cleaned as follows:

(a) Loosen the swagelok nut which connects the dampener to the bottom of the High Pressure Switch.

(b) Unscrew the dampener from the line.

(c) With a flat screwdriver remove the retaining screw from the valve cavity.

(d) Turn the dampener over and tap it on top of a workbench. The parts inside consisting of a plunger, sealing disc and bushing should drop out. If the parts are stuck, they can be pushed out by inserting a thin rod through the hole in the centre of the male end.

(e) Clean all the parts and the inside of the body.

(f) Place the plunger through the sealing disc into the appropriate hole of the bushing and insert into the valve body. The plunger should be placed into the number 3 hole for proper throttling effect.

NOTE

The scaling disc has a slight protrusion on one side around the hole. This side should face the bushing.

(g) Replace the retaining screw and connect the unit back into the System.

5.3.5 THE SOLENOID VALVE No regular maintenance is carried out on the Solenoid Valve. After extended use it is possible for the various components to wear out or become dirty. This could prevent proper sealing and result in leakage. The valve can be taken apart and the various parts cleaned or replaced. If no spares are available, the valve can be bypassed until a replacement is received. The coil and other electrical components are not repairable, therefore, there is no need to access the upper half of the housing.

5.3.5.1 Testing the Operation of the Solenoid Valve - The Solenoid Valve can be tested in the line as follows:

(a) With the Rectifier ON and valve V-3 closed, press the Upper Limit switch S13. A distinct click should be heard as the solenoid coil energizes and the valve closes.

(b) Close the Tank Filling valve V-7, and open valve V-3.

(c) Let the compressor fill the line until the High Pressure switch is activated. Don't let the bell rise to the top and trip S13. The Solenoid valve should be shut for this test.

(d) Observe the pressure gauge between the Balston Filter and the Check Valve in the high pressure line. If there is a slow pressure drop in the line, then it is likely that the valve is leaking. If there is a sudden pressure drop to zero as soon as the compressor starts, it means that either the solenoid did not energize, or that the valve is stuck in the open position. Press S13 several times to see if the valve "unsticks".

(e) If the solenoid valve is not operating properly it should be removed and examined.

5.3.5.2 Removing the Solenoid Valve - The Solenoid Valve can be removed from the system as follows:

(a) Turn OFF the power to the generator.

(b) Disconnect the two solenoid leads inside the compressor junction box.

(c) Unscrew the top part of the coupling which attaches the valve to the junction box.

(d) Unscrew the two swagelok nuts from the In and Out ports of the valve.

(e) Pull the valve down away from the junction box together with the leads.

(f) The valve can now be taken apart for examination.

5.3.5.3 Disassembling the Solenoid Valve - The valve can be taken apart as follows:

(a) Unscrew the stainless steel valve body from the solenoid housing. This can be done by placing the housing in a vice and loosening the valve with a wrench. If the plate underneath the housing gasket twists as the valve is turned, it will have to be clamped in the vice as well.

(b) Gently remove the valve body. The spring, core assembly, and upper body gasket will be exposed. Examine these parts and clean or replace as required.

(c) Remove the End Cap from the bottom of the valve. The disc holder with disc, the spring, and the lower body gasket will be exposed. Examine these parts and clean or replace as required. If no spare disc holder is available, the disc itself can be pushed out and reversed in the holder.

(d) Ensure that the openings in the valve body are clean and unobstructed.

(e) Reassemble the valve and bench test its operation. In reassembly, ensure that the numbers 1, 2, 3 are on the bottom of the valve body next to the plug.

5.3.5.4 Bench Testing the Solenoid Valve - After the valve is reassembled, before it is replaced in the system, it can be tested as follows:

(a) Blow into the IN port of the valve. It should be open and air should flow freely.

(b) Connect the two black leads to a 120 Vac power supply. A click should be heard as the solenoid energizes.

(c) While the solenoid is energized, blow into the IN port of the valve. The valve should be closed and airtight.

(d) Replace the valve in the system and do in-line tests as in para. 5.3.5.1.

5.3.5.5 Bypassing the Solenoid Valve - If the solenoid valve becomes unserviceable and can not be repaired on station, it can be bypassed so that the Electolytic Hydrogen Generator can continue to operate. Proceed as follows:

(a) Unscrew the swagelok nut which is connected to the drain valve V-4.

(b) Unscrew the swagelok nuts from both sides of the stainless steel "T" and remove the T-fitting.

(c) Insert valve V-4 in place of the 'T' so that gas flows from the solenoid through V-4 to the vent.

(d) Open the valve a fraction so that when pressure builds up in the line there will be a very slight leak through the valve. The rate of leakage can be observed on the pressure gauge connected into the line.

5.3.5.5.1 The reason for creating a controlled leak is the same as the original purpose for the solenoid, to reduce line pressure so that the compressor motor starts under zero load. With the solenoid bypassed, the compression rate will be slower because some of the gas will be venting to the outside. For this reason, the valve should be repaired or replaced as quickly as possible.

5.3.5.5.2 If the solenoid valve becomes unserviceable and remains closed, the fault is likely with solenoid coil. To bypass the valve with this problem it is first necessary to disassemble the valve and remove the core spring from the upper section. This will ensure that the valve remains open. Then follow the bypass instructions.

5.3.6 THE PRESSURE DIFFERENTIAL SWITCH (PDS) No regular maintenance is carried out on the PDS. The sensitivity of the switch is checked each time the balloon is filled and minor adjustments can be made as required. If the switch is not working properly, it can be checked for defects and either replaced, or if spare parts are available repaired. Before maintenance is performed, it must be confirmed that the problem is with the switch and not with the Nupro Check valve. Refer to para. 5.3.3.2 for check valve testing procedures.

5.3.6.1 Adjusting the PDS - The switch is factory preset to be activated at a pressure drop of 1 psi. This setting is very close to its low pressure limit. A snap action disc spring inside the switch body which causes the switch to trip could be stuck at such a low pressure making the switch unserviceable. In this case the pressure can be adjusted upwards so that the spring is reset. Adjust switch pressure as follows:

(a) Remove the switch cover.

(b) The adjusting nut with protruding fins is accessible and can be moved with fingers.

(c) Turn the nut counterclockwise to increase the pressure and clockwise to decrease the pressure.

(d) Set to the desired pressure by reading the range scale at the top of the adjusting nut assembly.

(e) Check the operation of the PDS by releasing some gas out of the high pressure line through the balloon filling valve. After a few seconds of pressure drop, the rectifier should shut down.

(f) If the switch is not activated by a drop in line pressure further checks can be made.

5.3.6.2 Checking the Operation of the PDS - The PDS is connected into the Rectifier Control Circuit in the normally closed position. When there is a pressure drop in the line the switch should open causing the circuit to deenergize. To check the operation of the switch proceed as follows:

(a) Turn the power to the generator OFF.

(b) Close the tank inlet valve V-8 and release the line pressure through balloon filling valve V-9.

(c) Remove the cover from the TB5 Junction Box.

(d) Disconnect the two leads which are connected into the PDS (TB5-17 red, and TB5-1 brown).

(e) Connect an ohmmeter across these leads. The switch should be closed.

(f) Remove the 'U' tube section connected to the Low Pressure port of the switch.

(g) Clamp a piece of clean hose to the nipple of the Low Pressure port.

(h) Suck on the hose. Without too much pressure, the switch should click, and continuity as shown on the meter should be broken.

(i) If the switch is not operating properly, increase the pressure setting to approximately 3 psi then repeat step (h). If the switch is still not operational, follow removal and repair or replacement procedures.

5.3.6.3 Removal of the PDS - To remove the switch from the system, proceed as follows:

(a) Turn off the power to the Electolytic Hydrogen Generator.

(b) Remove the cover from the box, housing TB5.

(c) Disconnect the four leads connecting the switch to TB5 (terminals 17, 1, 15, 5).

(d) Remove the stainless steel tube segments connected to the Low and High pressure sides of the switch.

(e) Remove the two nuts which hold the switch housing to the front panel.

(f) Unscrew the top part of the coupling from the top of the switch.

(g) Pull the switch away from the panel and down together with the leads.

(h) The switch can now be replaced with a spare unit or checked and repaired.

5.3.6.4 Checking the Operation of the Microswitch - After the switch has been removed from the system, the operation of the microswitch can be checked as follows:

(a) Remove the switch cover.

(b) Connect an ohmmeter across the red and brown leads of the switch. It should indicate continuity because with no pressure in the line the switch should be closed.

(c) With a small screwdriver press the microswitch actuator. This is a small horizontal lever located in the top of the housing above the vertical centre post of the adjusting assembly.

(d) When the actuator is pressed, the switch should open. When released, the switch should close. If the microswitch is not operating properly, the switch should be sent out for repairs. If the microswitch operation is normal, the diaphragm assembly can be checked.

5.3.6.5 Checking the Diaphragm Assembly - The diaphragm assembly can be taken apart and checked as follows:

(a) Loosen and remove the screws from the bottom of the diaphragm housing.

(b) Pull the bottom section out together with the O-rings, diaphragm and actuation plate.

(c) Examine the diaphragm and 0-rings for wear. Clean and replace if necessary.

(d) Clean out any dirt or moisture from the inside of the housing.

(e) Reassemble the switch ensuring that the indentation in the centre of the actuation plate is sticking out, upwards towards the microswitch. Tighten the screws on the bottom plate by the alternating method and applying uniform pressure all the way around.

(f) Check the action of the switch as follows:

(i) Adjust the switch pressure to approximately 2 psi.

(ii) Clamp a hose to the low pressure side of the switch.

(iii) Connect an ohmmeter to the red and brown leads of the switch. It should indicate continuity.

(iv) Suck on the hose. A click should be heard and the meter should indicate an open circuit.

(g) If the switch is working normally, put it back in operation. If it is defective, replace with a spare and send it out for repairs.

5.3.7 THE HIGH PRESSURE SWITCH (HPS) No regular maintenance is carried out on the High Pressure switch. The switch pressure setting is checked on a regular basis and adjustments are made as required. If the switch becomes unserviceable it is either replaced, or if spare parts are available repaired.

5.3.7.1 Checking the Operation of the HPS - The High Pressure switch is connected in the normally closed position (Red and Brown leads). When the line pressure reaches activation point, the switch should be open. To check the operation of the switch proceed as follows:

(a) Turn OFF the power to the generator.

(b) Ensure there is no pressure in the line by closing the tank filling valve V-8, and opening the balloon filling valve V-9.

(c) Remove the cover from the Junction Box on top of the Electolytic Hydrogen Generator and disconnect the two wires from TB5 which connect to the HPS (TB5-7 red and TB5-11 brown).

(d) Connect an ohmmeter across these wires and check for continuity. The switch should be closed.

(e) Adjust the HPS setting to 90 psi.

(f) Power up the system.

(g) Start the compressor and let the pressure in the line build up to the switch setting. At the tripping point the switch should open. This can be observed on the ohmmeter.

(h) If the switch does not trip at 90 psi, allow the pressure to build up to 100 psi, then if the switch still does not trip, open the Compressor Inlet switch.

NOTE

The switch is disconnected from the system, therefore it will not shut the compressor off automatically. This is why the Compressor Inlet switch is opened, to shut off the compressor before it exceeds 100 psi.

(i) If the switch does not trip, then either the microswitch or the diaphragm assembly is defective. Remove the switch and examine the components.

5.3.7.2 Removing the High Pressure Switch - To remove the HPS from the system, proceed as follows:

(a) Switch Off the power to the Electolytic Hydrogen Generator.

(b) Reduce the pressure in the line through the balloon filling valve.

(c) Remove the stainless steel tubes connecting the HPS to the pressure gauge, and to the high pressure line.

(d) Remove the two nuts which attach the switch housing to the front panel.

(e) Unscrew the top part of the coupling from the top of the switch.

(f) Disconnect the four leads connecting the HPS to TB5 (terminals 5, 6, 7 and 11).

(g) Pull the switch away from the frame and down together with the leads.

(h) The switch can now be taken apart and the various parts examined.

5.3.7.3 Checking the Operation of the Microswitch - After the HPS has been removed from the system the operation of the microswitch can be checked as follows:

(a) Remove the switch cover.

(b) Connect an ohmmeter to the red and brown leads. The switch should be closed.

(c) With a small screwdriver press the microswitch actuator. This is a small horizontal lever located in the top of the housing above the vertical centre post of the adjusting assembly.

(d) When the actuator is pressed, the switch should open. When released it should close. If the microswitch is not operating properly, the HPS should be sent out for repairs.

(e) If the microswitch operation is normal, the diaphragm assembly can be examined.

5.3.7.4 Checking the Diaphragm Assembly - The diaphragm assembly can be taken apart and checked as follows:

(a) Loosen and remove the screws from the bottom of the diaphragm housing.

(b) Pull the bottom section out together with the 0-ring, diaphragms and actuation rings.

(c) Examine the diaphragms and 0-ring for damage. Replace if necessary. Clean out any dirt.

(d) Check the action of the switch as follows:

(i) Reduce the pressure setting on the switch to approximately 20 psi.

(ii) Place the centre actuating plate over the centre pin. Ensure that the indentation in the plate is sticking out upwards toward the switch.

(iii) Connect an ohmmeter across the red and brown leads of the switch. It should indicate continuity.

(iv) Firmly press the actuation plate. A distinct click should be heard as the switch is tripped and the continuity on the meter should be broken.

(e) If the switch response is not as it should be, there is probably a problem with the switching mechanism inside the housing. The switch should be sent out for repairs.

(f) If the switch operation is normal, reassemble the unit ensuring that the actuation plate is facing the right way. Tighten the screws of the bottom plate using the alternating method and applying uniform pressure all the way around.

5.3.8 LIMIT SWITCHES Five Limit Switches are used on the Electolytic Hydrogen Generator. They are connected into the TB5 Junction Box with pyrotenax cables. All the switches are basically the same type although some are connected in the normally open and some in the normally closed position. The four switches around the gasholder, S17, S15, S14 and S13 have a roller-arm type tripping mechanism. The Compressor Inlet Switch S16 has a plunger type actuator.

5.3.8.1 Checking the Alignment of the Limit Switches The switches around the gasholder should be set up so that the roller arm is horizontally centered in the pipe where it is tripped. It should be far enough into the pipe to be tripped easily by the weight, but not too far so that the weight cannot get wedged above or below the arm.

5.3.8.1.1 The switches should be aligned vertically along the pipe as follows:

(a) S17 - This Upper Limit switch should be mounted so that it trips before the gasholder starts to vent. It should also be above the tripping point of S13. Its function is to switch off the compressor normal light if the gasholder rises above the point where the compressor should have started.

(b) S13 - This Upper Limit switch should be mounted so that it trips slightly before S17 as the gasholder rises. Its function is to start the compressor and energize the solenoid valve.

(c) S15 - The lower of the two Low Limit switches should be mounted slightly below S14 so that it is tripped before the gasholder reaches the bottom. It's function is to switch the rectifier Off if S14 fails to stop the compressor.

(d) S14 - The higher Low Limit switch should be mounted slightly above S15. Its function is to switch off the compressor at the end of the cycle.

5.3.8.1.2 To adjust the switch vertically or rotate it horizontally:

(a) Loosen the Allen screw which attaches the switch bracket to the mounting rod. The amount of movement is limited because of the pyrotenax but minor adjustments can be made.

(b) Move the switch assembly until proper positioning is obtained.

5.3.8.2 Adjusting the Roller Arm If the roller arm is sticking out too far so that the lead weight does not trip it, or is pushed too far in so that the weight can not get by it, it can be adjusted as follows:

(a) Hold the roller arm and loosen the outer lock nut.

(b) Pull the roller arm out away from the serrated fluted washer.

(c) Rotate the arm slightly in the desired direction.

(d) Push the arm back against the fluted washer until the serrations catch.

(e) Hold the roller arm and tighten the lock nut sufficiently to prevent slippage of the arm. Do not overtighten.

(f) Check the operation of the switch by raising and lowering the lead weight past the roller arm.

5.3.8.3 Checking the Operation of the Limit Switches The basic operation of the microswitches is checked weekly as part of the Operational Maintenance (Reference para. 4.4.4.5). If the switch does not function properly during these checks, further tests have to be made.

5.3.8.3.1 The opening and closing action of the switches can be checked with an ohmmeter. The switches are wired into TB5 as follows:

S13 - TB5-8 and TB5-12 - normally open

S14 - TB5-12 and TB5-16 - normally closed

S15 - TB5-10 and TB5-17 - normally closed

S16 - TB5-2 and TB5-16 - normally open

S17 - TB5-3 and TB5-13 - normally closed

(a) With the power OFF, disconnect the leads of the switch to be checked from the appropriate terminals on TB5.

NOTE

Ensure during this check that the switch is not being tripped by the lead weight or in case of S16, ensure that the handle of IVLS (V-3) is away from the switch plunger.

(b) Connect an ohmmeter across the two leads. If the switch is wired in the normally open position, the meter should indicate infinity. If the switch is wired in the normally closed position, the meter should indicate continuity.

(c) Manually activate the switch. The meter should indicate opposite to the previous reading.

(d) Release the switch actuator. The meter should indicate original reading.

5.3.8.3.2 If the switch operation is normal but the Electolytic Hydrogen Generator does not respond properly to it, the fault is elsewhere in the system. If the switch is defective, it can be removed for examination and either repaired or replaced.

5.3.8.4 Removing the Switch If it is determined that the switch is defective, it can be removed as follows:

(a) Remove the switch cover.

(b) Unscrew the 4 pyrotenax leads from the terminals of the microswitch.

(c) Remove the pyrotenax from the switch by first loosening the outer retaining nut and then unscrewing the connector from the housing.

(d) Remove the two screws which hold the switch to the bracket. S16 is attached with two screws to the front panel.

(e) Pull out the switch from the pyrotenax.

5.3.8.5 Examining the Switch After the switch is removed from the system examine it as follows:

(a) Manually press on the roller arm or plunger and observe the action of the actuator.

(i) On a switch with a roller arm, the lever should press down on the microswitch and a click should be heard as the switch is activated. When the arm is released, a spring should cause the lever to return to its original position and a second click should be heard as the switch actuator is released.

(ii) On the compressor inlet switch, the plunger should press down on the microswitch until a click is heard. When released, a spring should cause the plunger to return to its original position and a second click should be heard.

(b) Connect an ohmmeter across the appropriate terminals of the microswitch and check its operation as in para. 5.3.8.3.

(c) If the switch is defective, replace with a spare. If the switch is operating normally when it is removed from the system but not while it is connected, the problem could be with the pyrotenax. The wires inside could be shorted or broken.

5.3.8.6 Pyrotenax Wiring Check To check the wires proceed as follows:

(a) Ensure that the leads at both ends of the pyrotenax are disconnected from the terminals.

(b) Connect one test lead of an ohmmeter to the black wire at either end of the pyrotenax, and the second lead to the outside casing. If the meter indicates continuity, there is a short between the wire and the casing, and the pyrotenax section will have to be replaced.

(c) With one test lead connected to the black wire at one end of the pyrotenax, connect the second lead to the black wire at the other end. If there is no continuity, the wire is broken and the pyrotenax will have to be replaced.

(d) Repeat steps (b) and (c) with the white wire.

(e) Ensure that the white and black wires are not touching at either end of the pyrotenax.

(f) Connect one lead of an ohmmeter to the white wire and the second lead to the black wire. The meter should indicate an open circuit. If there is continuity, there is a short between the two wires and the pyrotenax will have to be replaced.

5.3.9 THE COMPRESSOR Limited maintenance is performed on the compressor in the field. Operational maintenance consists of regular oil change (para. 4.4.5.4). Corrective maintenance involves replacing the compressor or compressor head with a spare and shipping the defective unit out for repairs. A leak around the compressor head or around the inspection plate can be fixed by installing a new gasket. If there is a gas leak around the back plate, the repairs can not be done in the field. The back plate fits over the crankshaft bearing and critical spacing and alignment is involved in reassembly.

5.3.9.1 Testing the Operation of the Compressor The compressor can be tested in the system by allowing it to build up line pressure to 100 psi as follows:

(a) Close the hydrogen to storage tank valve V-7.

(b) Turn the compressor on and allow it to build up pressure in the line. After initial hesitation, the line pressure should build up rapidly until the HPS is activated.

(c) If the operation of the compressor is sluggish and it takes longer than normal to build up the line pressure, it is possible that the suction and discharge valves in the head are dirty or worn. Check for leaks around the head gasket, inspection plate gasket and around the crankshaft cover. Replace the gasket if leaks are found. Replace the head or the whole compressor if necessary.

5.3.9.2 Replacing the Compressor Head If it is suspected that the valves in the compressor head are defective, the head can be replaced with a spare as follows:

(a) Turn OFF the power to the generator.

(b) Unscrew the swagelok nuts from the inlet and outlet sides of the compressor head.

(c) Unscrew the connector fittings from both sides of the head.

(d) Remove the four bolts which attach the head to the cylinder.

(e) Lift the head from the cylinder. If it sticks, gently insert a putty knife blade under the head and work it around to loosen the bond. Do not force a screwdriver or a chisel under the head as damage to the surface will result.

(f) Rotate the crank until the piston reaches the top of the cylinder.

(g) Remove any pieces of gasket that might be stuck by gently scrapping it off with a knife blade or scraper.

(h) Place a new gasket and cylinder head on the compressor.

(i) Replace and tighten the four head bolts. Tighten the bolts evenly on all sides increasing the torque to approximately 50 ft. lbs.

(j) Wrap teflon tape on the threads of the fittings which screw into the compressor head and tighten them into place.

(k) Replace the swagelok nuts and test the operation of the compressor as in para. 5.3.9.1. Send the defective head out for repairs.

5.3.9.3 Replacing the Compressor If replacement of the compressor head does not improve the compression rate, the problem is likely with the piston or piston rings and the compressor will have to be replaced. If there is a leak around the back plate, the plate bolts can be tightened. Avoid overtightening and ensure that uniform pressure is applied to all the bolts. If the leak can not be stopped, replace the compressor. To remove the compressor proceed as follows:

(a) Turn the generator power OFF.

(b) Close the 'COMPRESSOR INLET' valve V-3.

(c) Drain the oil out of the compressor.

(d) Remove the stainless steel tube connected to the oil drain.

(e) Remove the cooling coils.

(f) Unscrew the swagelok nut from the inlet side of the compressor head.

(g) Remove the fittings from the inlet and outlet sides of the compressor head.

(h) Unscrew the four bolts holding the base of the compressor to the mounting plate.

(i) Remove the drive belt.

(j) Remove the compressor and install the new one in reverse order to the above.

(k) Ensure that oil is added then check out the operation of the compressor as in para. 5.3.9.1. Send the defective compressor out for repairs.

5.3.10 THE COMPRESSOR MOTOR If the compressor motor does not start after troubleshooting procedures in para. 5.2.6 have been followed, replace the motor as follows:

(a) Turn OFF the power to the generator at the Control Alarm Panel.

(b) Remove the cover from the Junction Box.

(c) Disconnect the wires including ground which connect to the motor. Mark the wires to ensure that correct ones are reconnected after replacement.

(d) Unscrew the liquid tight connector from the elbow above the junction box.

(e) Pull out the wires through the top of the junction box.

(f) Unscrew the bolts on the motor housing from the mainframe.

(g) Pull the motor out.

(h) Install a new motor using the fittings from the old one including the pulley.

(i) Check the belt. If cracked or frayed replace with a new one.

5.3.11 THE CELL Limited maintenance is performed on the cell in the field. If there is a leak around the gasket the head bolts can be tightened or a new gasket installed. If there is a leak around the insulator nuts or connectors, they can be removed and replaced with new ones. If the cell produces hydrogen with oxygen content that is above the acceptable limit, the cell is normally removed and either replaced with spare or bypassed. The bad cell can be taken apart and examined for obvious defects and if necessary shipped out for repairs.

5.3.11.1 Removing the Cell The cell is heavy and awkward to handle and two people are normally required to remove it from the generator. Proceed as follows:

(a) Shut OFF the power to the generator.

(b) Disconnect the buss bars from the cell.

(c) Remove the vent tubes and gas takeoff tubes from the top of the cell.

(d) Disconnect the water feed hose from the cell and tie off the hose.

(e) Remove the electrolyte from the cell (refer to para. 4.7).

(f) Remove the two bolts underneath the generator which thread into the bottom of the cell.

(g) With one person at each end of the cell, lift and carry the cell away from the generator.

(h) If the cell is to be shipped, the rest of the electrolyte can be drained off by lying the cell on its side and lifting the bottom until the electrolyte has drained out. The cell should then be thoroughly rinsed out with water and allowed to dry to prevent any leakage during shipment.

5.3.11.2 Disassembling the Cell - Following procedures are used when taking the cell apart for examination or gasket replacement:

**WARNING**

The asbestos skirt and all the parts are coated with electrolyte. Wear protective clothing and handle the cell with care.

(a) Remove the sight glass.

(b) Remove the 24 stainless steel nuts from the cell head bolts.

(c) Grasp the cell cover by the collector pipes and lift. The cover and gasket should separate from the tank and the whole cell assembly can be lifted.

(d) Move the cathode spacer to a vertical position so that the cell assembly can be lifted out of the tank. The spacer is located on the side of the cathode near the bottom. It is very awkward to reach. Have one person lift the cell and hold it near the top of the tank while the second person hits the spacer with a long screwdriver in a counterclockwise direction until it is in a vertical position. If the spacer is very stiff, the bolt holding it to the cathode might have to be loosened with a wrench.

(e) Lift the cathode assembly out of the tank. If the cell was removed because of a leaky gasket, a new cell gasket can be installed at this point and the cell reassembled.

(f) Without further disassembly, the cathode can be checked for wear and rusting. To remove the cathode go on to the next step.

(g) Remove the two insulator nuts from the cathode terminals. It is not necessary to remove the connector. The connector is sealed in the cell cover and may have hardened. It could crack or break off under pressure.

(h) Lift the cell cover and skirt out of the cathode. If the cathode sticks, press down on the terminal rods as you lift the cover.

(i) Examine the skirt assembly. If there was a problem with high oxygen content, the skirt is likely damaged.

(i) Ensure that there are no holes or tears in the asbestos.

(ii) Check the clamp strip which attaches the skirt to the cell cover.

(iii) Ensure that the bolts are tight and there are no cracks.

(iv) Check that the bottom of the skirt is sewn together. If the skirt is damaged and cannot be repaired, reassemble the cell and ship it out.

NOTE

There is no need to disassemble the cell beyond this point. If the anode inside the skirt is damaged, it cannot be repaired in the field.

(j) Rinse the asbestos skirt, cathode and all the cell parts with clean water.

(k) Flush all the sediment out of the cell tank.

(l) Allow the parts to dry a little then reassemble the cell.

5.3.11.3 Assembling the Cell Putting the cell back together is basically the reverse of taking it apart. Proceed as follows:

(a) Ensure that the bottom of the skirt is sewn together.

(b) Lift the cell cover together with the anode and skirt and fit it inside the cathode. This will be a tight fit and the skirt will tend to fold up as it is pushed between the plates of the cathode. One person should keep the cloth from folding while the second is lifting the assembly into the cathode. The cathode terminal rods fit through the connectors and extend above the cell cover.

(c) Tighten the terminal nuts that hold the cathode in place.

(d) Install a new gasket. Pull the old one off the cell bolts and push the new one over the threads.

(e) Lift the assembly into the cell tank. When the bottom of the cathode goes below the narrow neck of the tank, the cathode spacer should be moved to the horizontal position and the cell lowered into the tank. Ensure that the sight glass hole in the cover is on the same side as the sight glass fitting in the tank body.

(f) Tighten the cell head bolts to 4 pounds torque. Start with the two bolts in the centre of the cell and work outwards on both sides. Tighten evenly, gradually increasing the pressure to 4 pounds. If after the cell is installed there is a leak around the gasket, the torque can be increased.

(g) Replace the sight glass. Do not overtighten the swagelok fittings.

(h) Loosely screw the insulators into the bottom of the tank and lift the cell into place.

(i) Adjust the insulators until the cell is at the same height as the others.

(j) Fit the bolts with washers through the bottom of the Electolytic Hydrogen Generator and screw them into the insulators.

(k) Wash out and reconnect the gas takeoff tubes, overflow tubes, and water feed tube.

(l) Coat the threads of the terminal rods lightly with copper grease and connect the buss bars.

(m) Refill the cells with Electrolyte (reference para. 4.7).

(n) Restart the system and check the purity of hydrogen produced by the cell.

(o) Check for gas leaks around the gasket and the takeoff tubes.

5.3.11.4 Bypassing a Cell If a defective cell is sent out for repairs and there is no spare on station, the generator can continue to operate if the cell is bypassed. The gas production rate will be slower with one cell removed.

5.3.11.4.1 To bypass a cell, connect jumper cables so that the anode of each cell is still connected to the cathode of the next.

5.3.11.4.2 If one of the end cells is removed, move one of the others in its place so that the main buss bar connections can be maintained. Plug up the holes in the headers where the cell was connected so that hydrogen does not leak out.

5.3.11.4.3 When the defective cell is repaired, it should be put back into the system.

5.3.11.5 Terminal Insulator Replacement The plastic terminal insulators are used around the cell terminal rods to insulate the rods from the cell body and to prevent gas from leaking around the rods. The connector part of the insulator fits over the rod and screws into the cell cover. The nut part fits over the rod and screws onto the connector. Refer to figure 6-3. As the nut is tightened it seals the space around the rod. If due to wear or damage, gas begins to leak around the terminal nut, the nut can be tightened. Do not tighten more than required to stop the leak.

**CAUTION**

When tightening the nut, ensure that the wrench is not turning both the nut and the connector. This could result in damage to the connector.

5.3.11.5.1 If the nut is tightened to its maximum, i.e. the head is snug against the connector, and the leak persists, replace the nut with a new one. If the new nut is tightened and gas is still leaking, unscrew the connector from the cell and replace with a new one. Wrap teflon tape twice around the thread of the connector before it is screwed into the cell.

5.3.11.5.2 During the removal and sometimes during shipment, the connector body may break off leaving the threaded end in the cell. A special drill supplied to each station is required to remove the broken connector. Proceed as follows:

(a) Attach the special drill bit to a hand drill or a variable speed electric drill. If an electric drill is used remove the cell and carry out the repairs in a non hazardous location.

(b) Place the drilling tool over the terminal rod. If the rod is bent and there is a problem fitting the tool over it, straighten out or file the rod until it fits. Apply some grease or oil on the rod for smoother drilling.

NOTE

Operate the drill at low speed. High speed will melt the plastic and clog the teeth.

(c) Lift the drilling tool frequently to clean the teeth.

(d) As the drill is pushed deeper, pieces of plastic may have to be pried out of the hole with a pick.

(e) Once the insulator has been drilled out to the full depth of the tool, screw a reamer into the cavity to clean out the threads. The reamer is simply a piece of threaded pipe which is the same diameter and thread as the hole. Do not cross-thread.

(f) Wrap teflon tape twice around the thread of the new connector and screw into the cell.

5.3.12 THE LOW PRESSURE SWITCH This switch is an electromechanical device. Gas pressure in the Low Pressure Line keeps a mercury switch closed completing a circuit to the Control Alarm Panel. The sensitivity of the switch is set at one inch water pressure and can be adjusted with a screw on the side of the switch. A visual check through the glass cover will show if the switch is activated. If the mercury is at the wired end of the bulb then the switch should be closed. When there is a drop in line pressure the bulb will tilt causing the mercury to flow away from the wires and the circuit will open. Once pressure has been restored in the line a lever on the side of the switch is pressed and the switch is reset to the closed position. The action of the switch is checked during regular monthly maintenance (para. 4.4.5.5). If it is determined that the switch is not operating properly further testing to determine whether the switch is mechanically or electrically defective is required.

5.3.12.1 Testing The Mechanical Operation Of The Switch Proceed as follows:

(a) Turn OFF the power to the generator.

(b) Drain the Gasholder completely as follows:

(i) Open the Gasholder Vent valve V-17.

(ii) Let the bell drop until it stops.

**WARNING**

The Gasholder must be completely drained before proceeding with switch testing.

(c) Disconnect the stainless steel tube which connects to the switch at the swagelok fitting outside the cubicle.

(d) Attach a piece of hose to the tube connected to the switch.

(e) Blow into the hose and press the reset switch at the same time. The switch should reset.

(f) If the mercury switch fails to reset or if there is loss of pressure through the switch, the unit is defective and should be replaced. Proceed to para. 5.3.12.3 step (c).

(g) If the switch is normal in this test but does not reset while in operation, problem could be with a leak in the line, a plugged line, or the gasholder being hung up during the compression cycle.

(h) If everything checks out normal, reactivate the Gasholder. Refer to para. 4.4.1 'Hydrogen Generator start up procedure'.

5.3.12.2 Testing The Electrical Operation Of The Switch The electrical operation of the switch can be checked with an ohmmeter. This is done when the mercury bulb resets properly but the circuit fails to energize. Proceed as follows:

(a) Ensure that the power to the generator is turned OFF.

(b) Disconnect one of the yellow wires which connect to the switch (either at TB1-4 or TB2-4).

(c) Connect an ohmmeter to the two yellow leads from (b). When the mercury in the bulb is at the wired end, the switch should be closed and the meter should indicate continuity.

(d) If the circuit is open check the wire to the switch. Repair the wire or replace the switch as required.

5.3.12.3 Replacing the Switch - If it is determined that the switch is defective, it should be replaced as follows:

(a) Switch OFF the power to the generator.

(b) Drain the Gasholder completely as follows:

(i) Open the Gasholder Vent valve V-17.

(ii) Let the bell drop until it stops.

**WARNING**

The Gasholder must be completely drained before proceeding with switch replacement.

(c) Disconnect the two yellow leads which connect to the switch at TB1-4 and TB2-4.

(d) Remove the swagelok fitting which connects the gas tube from the switch to the Low Pressure line. This fitting is just outside the cubicle. Plastic ferrules are used so that the swagelok nut can be pulled off. Save these ferrules for reassembly. Do not use stainless steel ferrules.

(e) Remove the two nuts which hold the switch to the mounting plate.

(f) Unscrew the swagelok nut which attaches the plastic vent tube to the switch.

(g) Pull out the switch together with the mounting plate.

(h) Separate the switch from the mounting plate by removing the four screws from the back of the plate.

(i) Install a new switch in the reverse order to the above and test its operation in the system.

(j) Reactivate the Gasholder. Refer to para. 4.4.1 'Hydrogen Generator start up procedure'.

5.3.13 THE MANOMETERS Maintenance consists of adding liquid to the tube or disassembling the manometer in order to clean or replace the U-tube.

5.3.13.1 Adding Fluid The manometer should have enough liquid so that when there is no pressure in the line to which they are connected they indicate 'zero' on the scale. Evaporation over a period of time will reduce the level or sudden increase in pressure could result in some of the fluid being blown out of the tube. Small adjustments can be made by moving the scale down. Fluid can be added without the need for disassembly of the manometer.

NOTE

To prevent freeze-up, an antifreeze mixture can be used instead of water.

(a) Set the scale to its midrange.

(b) Place the fluid in a small squeeze type plastic bottle.

(c) Insert the tip of the bottle into the open end of the manometer behind the front panel of the generator.

(d) Squeeze slowly until some of the liquid is forced into the tube. Let the liquid drain down to the bottom and observe the level. Add more liquid as required.

5.3.13.2 Removal of Manometer Tube To clean the manometer tube or replace a broken one remove as follows:

(a) Remove the two screws attaching the scale to the manometer and pull the scale off. There are spacers behind the scale that will drop out so be careful that they don't get lost.

(b) Remove nut from top of manometer assembly and loosen the nut underneath.

(c) Remove the screw and cork padding supporting the bottom of the tube.

(d) Pull down on the tube wiggling slightly from side to side. The tube should pull out of the housing.

(e) Wash the tube or replace as required. Add new liquid before replacing the tube in the housing.

5.3.14 THE WALL VENT HEATER The wall vent heater ensures that the temperature around the vent remains above freezing. Two thermostats, inside the housing, control the on/off action of the heater. The range of the thermostats is between 50°F and 350°F. There are no dials on the thermostats. It has been determined that one quarter turn of the adjustment screw will give the correct setting. If it is found that the vent temperature falls below freezing and the circuit breaker CB5 in the cubicle is ON, the problem could be with the thermostats or with the wiring. Using the following procedures, remove the vent from the wall, take it apart and check the various components.

5.3.14.1 Removing the Wall Vent To remove the vent from the wall proceed as follows:

(a) Turn OFF the power to the generator at the Control Alarm Panel and toggle the 'HEATER' switch CB5 in the cubicle to the 'OFF' position.

(b) Remove cover from junction box at the vent and disconnect the leads inside.

(c) Disconnect the stainless steel tubing and the conduit from the housing.

(d) Loosen the bolt on the round flange which holds the vent against the wall, and pull the flange off the vent.

(e) Push vent housing out a few inches then go outside and pull it completely out.

5.3.14.2 Disassembling the Wall Vent To take the vent apart it may be necessary to place the housing in a vise. The original fittings were sealed with a compound and some pressure may be required to remove the fittings. Place the vent in a vise and proceed as follows:

(a) Unscrew and remove the temperature gauge.

(b) Remove the stainless steel connector from the pipe fitting.

(c) Using a pipe wrench unscrew the pipe fitting.

(d) Unscrew the large hex nut which holds the gas pipe to the housing.

(e) Make a mark somewhere on the front plate and housing so that the two sections can be realigned after disassembly.

(f) Remove the six bolts from the front plate of the heater.

(g) Pull out the heater assembly from the housing. The leads will allow only 6 to 8 inches of slack.

**WARNING**

Handle the asbestos cloth carefully. Do not shake it. Wear a dust mask and gloves.

(h) Unwrap the asbestos cloth from around the heater. Save the thread for rewrapping.

(i) Examine the wires and connections for wear. Replace if necessary. If new wiring is installed, use heat resistant asbestos insulated wire.

(j) Check the action of the thermostat as follows:

(i) Ensure that the leads from the heater are not touching and connect an ohmmeter across the connections of one of the thermostats.

(ii) Turn the adjusting screw on the thermostat slowly from zero stop fully clockwise. The contact should be open at zero and close at approximately 1/4 turn. The actual point of closing depends on room temperature.

(iii) Repeat steps (i) and (ii) for the other thermostat.

(k) If the contact remains open through the full range, the thermostat is defective and should be replaced.

(l) If the contact remains closed through the full range, there is a short in the thermostat and it should be replaced. If this type of a fault occurs with both thermostats the heater will not shut off. This would result in overheating and could create a very dangerous condition.

(m) Reassemble the vent and connect back into the system. Apply teflon tape on all threaded pipe connections. Do not apply tape to swagelok fittings.

5.3.15 THE FAN MOTOR The Fan Motor should switch on as soon as power is supplied to the generator.

5,3,15,1 If the fan does not start, ensure that 'FAN' breaker CB1 inside the cubicle is closed. If the fan does not start with CB1 on, check the voltage across terminals 1 and 2 on TB3 in the rear compartment of the cubicle.

5.3.15.2 If there is no voltage, trace the wires back to terminals 15 and 16 on TB1. If the voltage at TB3 is normal (120 Vac) and the fan does not work, the fan motor is probably defective. Replace the motor with a spare as follows:

(a) Turn OFF the power to the generator at the Control Alarm Panel and switch CB1 to the 'OFF' position.

(b) Disconnect the fan motor leads from TB3.

(c) Remove the screw holding the fan housing to the frame.

(d) Rotate the fan housing upwards so that the flange and fan fins are visible. The housing assembly is too large to be pulled out as a unit therefore it has to be taken apart in the cubicle.

(e) Remove the 3 screws holding the flange to the housing.

(f) With an Allen key loosen the set screw holding the fan to the motor shaft.

(g) Pull the fan off the shaft.

(h) With a small wrench or a nut driver remove the two nuts holding the motor to the blower housing.

(i) Pull out the motor and replace with a new one.

(j) Reassemble using above procedures in reverse order.

5.3.16 PURGING THE GASHOLDER If contaminated hydrogen from a faulty cell or during maintenance has entered the gasholder it may be necessary to purge the system. Once the source of air or contaminated gas has been eliminated and pure hydrogen is being produced by the cells, the gasholder can be purged as follows:

(a) Close the 'COMPRESSOR INLET' valve V-3.

(b) Open the Gasholder Vent valve V-17 and allow the bell to drop until the weight trips the higher of the low limit switches.

(c) Put the generator in operational mode and let the gasholder fill with hydrogen until the weight trips the Upper Limit switch.

(d) Repeat steps (b) and (c) ten times.

5.3.16.1 The gasholder and the lines should now be filled with pure hydrogen and the gas can be pumped into the storage tank.

5.3.16.2 If the contaminated gas has entered the storage tank, check gas purity in the tank using procedures in para. 4.4.4.2 and if necessary purge the tank.

5.3.17 PURGING THE STORAGE TANK If it is discovered that the gas purity in the storage tank is outside the acceptable limit of 1 percent oxygen, first the cause must be determined and the fault corrected, then the storage tank must be purged.

5.3.17.1 The easiest method for purging the storage tank is using an inert gas such as Helium or Nitrogen.

5.3.17.2 Helium is used as a standby source of gas and is available at most stations. Proceed as follows:

(a) Turn OFF the power to the generator.

(b) Disconnect the balloon filling hose from the filler stand.

(c) Connect a regulator valve to a helium bottle and attach the hose to the regulator.

(d) Adjust the regulator to 30 psi.

(e) Open valve V-14 at the top of the storage tank and release the impure hydrogen gas until tank pressure drops to 5 psi, then close valve V-14.

(f) Open the balloon filling valve at the wall and valves V-8 and V-9.

(g) Open the helium tank regulator valve and allow storage tank pressure to build up to 20 psi, then close valve V-9.

(h) Open valve V-14 and release the helium gas until tank pressure drops to 5 psi. then close valve V-14.

(i) Open valve V-9 and allow the storage tank pressure to build to 20 psi, then close valve V-9.

(j) Repeat steps (h) and (i) once more.

(k) Test the purity of gas in the storage tank (para. 4.4.4.2). If oxygen content is above 1% repeat steps (h) and (i) until gas purity is within limits.

(l) Disconnect the helium tank and start the generator with V-1 in 'TO VENT' position and the 'COMPRESSOR INLET' valve in the 'CLOSED' position.

(m) Do a gas purity check at valve V-15 to ensure that the cells are producing pure hydrogen. If the original gas was contaminated then the gasholder must be purged.

(n) Place V-1 in 'TO GASHOLDER' position, open the 'COMPRESSOR INLET' valve and allow the gas to be pumped into the tank.

5.3.18 CALIBRATION OF THE TC-2 REGULATOR The TC-2 Regulator is tested and adjusted at the factory but because of the differences in tolerances of the components in each generator, it may be necessary to do final adjustments in the circuit where the regulator is used. Two functions are adjusted during calibration, the overload setting and the maximum current setting.

5.3.18.1 The Overload Adjustment The overload should be adjusted so that the system trips at 285 amps. If the setting is too low, the regulator will be too sensitive and the unit will trip during normal power fluctuations. If the setting is too high, the unit will not shut down during high power surges and this could result in damage to the equipment. To adjust proceed as follows:

(a) Turn OFF the power to the generator.

(b) Remove the cover from the regulator and plug the regulator into the socket on the Control Module.

(c) Restore the power to the generator and operate it for a minimum of 2 hours before doing the adjustment.

(d) Using a small screwdriver turn the OVL adjustment pot (refer to figure 5-4) on the regulator counterclockwise one turn.

(e) Rotate R6 the 'CURRENT ADJUST' knob on the cubicle door fully clockwise .

(f) Adjust the CL pot on the regulator to read 300 amps on the panel meter.

(g) Set the 'CURRENT ADJUST' R6 to read 285 amps on the panel meter.

(h) Adjust the OVL pot clockwise until the 'OVERLOAD' light goes on. The generator will shut down.

(i) Rotate R6 counterclockwise and restart the generator.

(j) Rotate R6 slowly clockwise to test the overload setting. It should be 285 ±5 amps. If the setting is outside the limits, repeat the above procedures.

5.3.18.2 Maximum Current Setting The maximum current level should be set so that when the R6 current knob is adjusted fully clockwise, the meter will indicate 250 amps. With the power ON, proceed as follows:

(a) Adjust the R6 knob until the panel meter indicates 270 amps.

(b) Adjust the CL pot on the TC2 regulator (refer to figure 5-4) until the meter indicates 240 amps.

(c) Turn R6 fully clockwise.

(d) Adjust the CL pot until the meter indicates 250 amps.

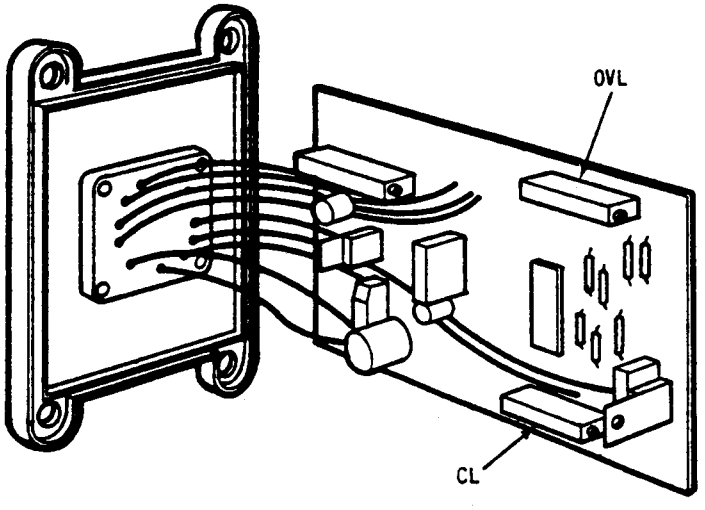



Figure 5-4 Regulator Adjustment

5.3.19 IDLE LEVEL ADJUSTMENT The idle level on the generator is set so that at an operational current of 230 amps, the generator will idle at 30 amps. To set the idle level proceed as follows:

(a) Open the cubicle door and pull out the maintenance switch.

(b) Set the generator into operational mode and adjust the rectifier current to 230 amps.

(c) Close the inlet valve at the tank and let the line pressure build up until the generator switches into idle mode.

(d) With a small flat screwdriver, adjust the R7 idle potentiometer in the cubicle until the meter reads 30 amps.

NOTE

A change in the operational current will result in a change in the idle level. If the generator is normally operating at less than 230 amps, then the idle level should be adjusted for 30 amps at the actual operating level.

# SECTION 6

# ILLUSTRATED PARTS BREAKDOWN

## INTRODUCTION

6.1 This Section lists and illustrates the components used to make up the Model M20-AES Electrolytic Hydrogen Generator. Figure 6-1 depicts a typical unit and the accompanying parts listing identifies the main areas and some components not shown in the remaining figures. The remaining figures are units, sub-units, circuit boards, and accompanying parts not separated into individual components in figure 6-1. Index numbers on the (exploded) illustration and in the 'Figure and Index' column of the associated parts list indicate, when appropriate, the order of disassembly for maintenance purposes. Component parts are indented to show relationship to the complete assembly. Attaching parts immediately follow the parts to which they attach and precede any detailed components when the attached part is an assembly.

## MANUFACTURERS' CODES

6.2 All parts other than readily available commercial hardware are identified in the detailed parts list with the manufacturer's code (Federal Supply Code Number) in parentheses immediately following the nomenclature in the description column. Table 6-1 relates the Code to the Name and Address information.

## ALPHA-NUMERICAL INDEX

6.3 In the Numerical Index, table 6-2, part numbers are listed in an alpha-numeric sequence. Order of preference for the first entry in the parts list column is numerals 0 to 9 and then letters A to Z. The order of preference for succeeding entries is as follows:

Space (blank column)
Dash (-)
Point (period)
Diagonal (slant)
Numerals 0 to 9.
Letters A to Z

The Figure and Index Number gives a cross-reference to the figure and index number of the applicable part in the parts list. The Quantity per Article column lists the total quantity of the applicable part for each indexing. The Stock Number column gives the AES stock numbers for stocked items.

## REFERENCE DESIGNATION INDEX

6.4 This index, table 6-3, lists all schematic reference designators assigned to electronic parts (and valve designators) in an alpha-numeric sequence. The Figure and Index column number lists the figure and index assigned to the applicable part. The Part Number column list manufacturers' part numbers.

## EXPLANATION OF PART LIST COLUMNS

6.5 The information contained in the parts list is described under the following headings.

6.5.1 FIGURE AND INDEX NUMBER COLUMN This column contains the figure number of the illustration associated with the specific parts list and the index number which has been assigned to each part on the illustration. A '-' prefixing an index number indicates the part is not illustrated or it is an assembly that has been broken down and it is not shown fully assembled. Index numbers that are prefixed with a '-' do not appear on the illustration.

6.5.2 PART NUMBER COLUMN This column contains the manufacturers part number for each item in the equipment. Drawing numbers have been assigned to AES manufactured or reworked items. When a part has not been assigned a part number - e.g. parts locally manufactured from bulk materials; the phrase 'NO NUMBER' will appear in this column.

6.5.3 DESCRIPTION COLUMN This column contains the name and a brief description of each part. When the part is available from a commercial source, the description is followed by the manufacturer's code in parentheses. The indention system employed in the "Description" column identifies the assembly hierarchy and permits the reader to determine all the parts required to make up an assembly and to determine the next higher assembly that a part is used in. The first item in a listing is listed without indention. All of the parts required to assemble that item are listed with one indention. When one of those parts is an assembly, all of the parts required for the assembly are listed with two indentions. This method of indention is continued until all of the assemblies and subassemblies have been disassembled to their replaceable detail parts, and each part of an assembly is indented one indention more than the assembly it is part of.

6.5.4 UNITS PER ASSEMBLY COLUMN This column indicates the quantity of each part that is required to assemble one unit of the next higher assembly. Abbreviations used and their meanings are:

AR - the quantity of the parts used is "as required".

REF - Item listed previously and shown in this listing for reference only.

6.5.5 STOCK NUMBER OR NATO STOCK NUMBER COLUMN This column lists the AES stock number or NATO stock number that has been assigned to specific parts.

Table 6-1 Manufacturers' Codes

| CODE | NAME AND ADDRESS | CANADIAN SOURCE/REPRESENTATIVE |
|---|---|---|
| 01816 | Canadian General Electric Co Ltd<br>Electronic Components Operation<br>189 Dufferin St<br>Toronto, Ont M6K 1Y9 | Safety Supplies<br>214 King St W<br>Toronto, Ont M5A 1J8 |
| 02324 | Electrohome Ltd<br>809 Wellington St N<br>Kitchener, Ont N2G 4J6 | Same |
| 02570 | Crawford Fitting Co<br>29500 Solon Rd<br>Solon, OH 44139 | Weston Valve & Fittings<br>3580 Wolfdale Rd<br>Mississauga, Ont L5C 2V6 |
| 03554 | Amphenol Canada<br>44 Metropolitan Rd<br>Scarborough, Ont M1R 2T9 | Same |
| 04845 | Automatic Switch Co<br>50-60 Hanover Rd<br>Florham Park, NJ 07932 | Westburne Electric<br>300 Steeprock Dr<br>Downsview, Ont MeJ 2W9 |
| 05083 | Bacharach Instrments<br>Div of United Technologies<br>301 Alpha Dr - RIDC Pk<br>Pittsburg, PA 15238 | Safety Supplies<br>214 King St W<br>Toronto, Ont M5A 1J8 |
| 06555 | Beede Electrical Instrument Co Inc<br>South Main St<br>Penacook, NH 03303 | Same |
| 08478 | Gardner-Denver Co Canada Ltd<br>1800 Ellesmere Ave<br>Scarborough, Ont M1H 2V5 | Same |
| 09049 | Custom Control Sensors Inc<br>21111 Plummer St<br>Chatsworth, CA 91311 | Willer Engineering<br>422 Consumers Rd<br>Willowdale, Ont M2J 1P8 |
| 09488 | Motorola Canada Ltd<br>3125 Steeles Ave E<br>Willowdale, Ont M2H 2H6 | Same |
| 09504 | Honeywell Ltd<br>155 Gordon Baker Rd<br>Willowdale, Ont M2H 3N7 | Same |

Table 6-1 Manufacturers' Codes (Cont'd)

| CODE | NAME AND ADDRESS | CANADIAN SOURCE/REPRESENTATIVE |
|---|---|---|
| 09819 | Canadian General Electric<br>Lamp Div<br>165 Dufferin St<br>Toronto, Ont M6K 1Y9 | Electro Sonic Inc<br>1100 Gordon Baker Rd<br>Willowdale, Ont M2H 3B3 |
| 11066 | Goodyear Canada Inc<br>3050 Lake Shore Blvd W<br>Toronto, Ont M8V 1K4 | Same |
| 12277 | Allen Bradley Canada Ltd<br>135 Dundas St<br>Cambridge, Ont N1R 5X1 | Union Electric<br>1491 Castlefield Ave<br>Toronto, Ont M6M 1Y5 |
| 12300 | Potter and Brumfield<br>AMF Canada Ltd<br>52 Royal Rd<br>Guelph, Ont N1H 7H1 | Same |
| 12623 | Whitey Co<br>318 Bishop Rd<br>Highland Heights, OH 44143 | Weston Valve & Fittings<br>3580 Wolfdale Rd<br>Mississauga, Ont L5C 2V6 |
| 18034 | Nupro Co<br>4800 E 345th St<br>Willoughby, OH 44094 | Weston Valve & Fittings<br>3580 Wolfdale Rd<br>Mississauga, Ont L5C 2V6 |
| 1P545 | Gould Inc (Chase-Shawmut)<br>Circuit Protection Division<br>374 Merrimac St<br>Newburyport, MA 01950 | |
| 31626 | Johnson Controls Inc<br>Control Products Div (Penn)<br>1302 E Monroe St<br>Goshen, IN 46526 | Johnson Controls Ltd<br>Johnson Poducts Div<br>929 Warden Ave<br>Scarborough, Ont M1L 4C6 |
| 36137 | Chromalox Canada Inc<br>(Fenwal Temperature Controls)<br>210 Rexdale Blvd<br>Rexdale, Ont M9W 1R4 | Same |
| 36401 | Atmospheric Environment Service<br>4905 Dufferin Street,<br>Downsview, Ont M3H 5T4 | Same |

Table 6-1 Manufacturers' Codes (Cont'd)

| CODE | NAME AND ADDRESS | CANADIAN SOURCE/REPRESENTATIVE |
|---|---|---|
| 37282 | The Electrolyser Corp Ltd<br>122 The West Mall<br>Etobicoke, Ont M9C 1B9 | Same |
| 38056 | Dresser Industries Inc (Ashcroft)<br>Industrial Instrument Operations<br>250 E. Main St<br>Stratford, CT 06497 | Ashcroft Products Cambridge<br>Dresser Canada Inc<br>6688 Kitimat Rd<br>Mississauga, Ont L5N 1P8 |
| 39739 | The Meriam Instrument Co<br>Div of The Scott and Fetzer Co<br>10920 Madison Ave<br>Cleveland, OH 44102 | The Electrolyser Corp Ltd<br>122 The West Mall<br>Etobicoke, Ont M9C 1B9 |
| 44655 | Ohmite Manufacturing Co<br>3601 West Howard St<br>Skokie, Il 60076 | Electo Sonic Inc<br>1100 Gordon Baker Rd<br>Willowdale, Ont M2H 3B3 |
| 51440 | Balston Inc<br>703 Massachusette Ave<br>PO Box C<br>Lexington, MA 02173 | Same |
| 59993 | International Rectifier<br>233 Kansas St<br>El Segundo, CA 90245 | Same |
| 71400 | McGraw-Edison Co, Bussmann Div<br>502 Earth City Plaza<br>PO Box 14460<br>St Louis, MO 63178 | GLE Inc<br>Bussmann Manufacturing<br>14 Connell Court<br>Toronto, Ont M8Z 1E7 |
| 72619 | Dialight Corp<br>203 Harrison Pl<br>Brooklyn, NY 11237 | Electro Sonic Inc<br>1100 Gordon Baker Rd<br>Willowdale, Ont M2H 3B3 |
| 73831 | Hammond Manufacturing Co Ltd<br>394 Edinburgh Rd N<br>Guelph, Ont N1H 1E5 | Same |
| 74193 | Heinemann Electric Co<br>5150 Dundas St W<br>Islington, Ont M9A 1C3 | Same |

Table 6-1 Manufacturers' Codes (Cont'd)

| CODE | NAME AND ADDRESS | CANADIAN SOURCE/REPRESENTATIVE |
|---|---|---|
| 81541 | Airpax Corp<br>Woods Rd, PO Box 520<br>Cambridge, MD 21613 | Kaytronics Inc<br>331 Bowes Rd<br>Concord, Ont L4K 1J2 |

Table 6-2 Alphanumeric Index

| PART NUMBER | FIGURE & INDEX NUMBER | QTY PER ARTICLE | STOCK OR NATO NUMBER |
|---|---|---|---|
| 0004-5191 | 6-21-3 | 3 | 0026-5187 |
| 0005-5007 | 6-27-5 | 1 | |
| 0023-1475 | 6-28-8 | 1 | |
| 0023-1487 | 6-28-6 | 1 | |
| 0023-4005 | 6-28-7 | 1 | 0026-5185 |
| 0023-4012 | 6-27-1 | 1 | |
| 0023-4019 | 6-27-2 | 1 | |
| 0023-4027 | 6-27-3 | 1 | |
| 0023-4098 | 6-28-3 | 1 | |
| 0023-4692 | 6-27-7 | 1 | |
| | 6-28-2 | 1 | |
| 0023-7260 | 6-28-1 | 1 | |
| 01-0661 | 6-26-5 | 4 | |
| | 6-26-12 | 4 | |
| 0104-7702 | 6-21-4 | 3 | |
| 02-3690 | 6-26-16 | 1 | |
| 100-12DX | 6-8-8 | 1 | 0026-5181 |
| 102035 | 6-17-1 | 1 | |
| 103-009 | 6-2-3 | 2 | 0026-3353 |
| 103-009 | 6-3-8 | 2 | |
| 103-010 | 6-3-9 | 4 | |
| 103-011 | 6-3-10 | 1 | 0026-2908 |
| 103-012 | 6-3-11 | 1 | |
| 103-019 | 6-2-5 | 2 | 0026-2917 |
| 103-019 | 6-3-19 | 2 | |
| 103-020 | 6-3-20 | 2 | |
| 103-021 | 6-3-22 | 2 | |
| 103-027 | 6-3-23 | 1 | |
| 103-032 | 6-3-16 | 1 | |
| 103-101 | 6-3-1 | 1 | 0026-6209 |
| 103-102 | 6-3-2 | 1 | |
| 103-103 | 6-3-5 | 1 | 0026-6207 |
| 103-104 | 6-3-6 | 1 | |
| 103-105 | 6-3-4 | 24 | |
| 103-108 | 6-3-15 | 1 | |
| 103-109 | 6-3-7 | 4 | |
| 103-110 | 6-3-17 | 1 | 0026-6203 |
| 103-111 | 6-3-21 | 2 | |
| 103-112 | 6-3-3 | 24 | |
| 103-113 | 6-3-24 | 1 | |
| 103-114 | 6-3-25 | 1 | |
| 103-115 | 6-3-26 | 1 | |
| 103-116 | 6-3-27 | 2 | |
| 103-117 | 6-3-28 | 2 | |
| 103-119 | 6-3-29 | 30 | |
| 103-120 | 6-3-30 | 4 | |
| 103-121 | 6-3-31 | 1 | |
| 103-122 | 6-3-32 | 1 | |
| 103-3101-1211-303 | 6-23-3 | 1 | |
| 103-3101-1212-303 | 6-23-2 | 1 | |
| 10AA25WM | 6-13-1 | 2 | 0026-3362 |
| 11-0019 | 6-26-2 | 1 | |
| 11-0020 | 6-26-8 | 1 | |
| 11-0021 | 6-26-13 | 1 | |
| 11-0026 | 6-26-3 | 1 | 0026-4580 |
| 11-0102 | 6-26-9 | 4 | |

| PART NUMBER | FIGURE & INDEX NUMBER | QTY PER ARTICLE | STOCK OR NATO NUMBER |
|---|---|---|---|
| 11-0105 | 6-26-15 | 1 | |
| 11-0106 | 6-26-23 | 1 | |
| 11-0109 | 6-26-17 | 2 | 0026-4581 |
| 11-0110 | 6-26-10 | 8 | |
| 11-0118 | 6-26-24 | 1 | |
| 10AA25WM | 6-13-1 | 2 | 0026-3362 |
| 11-0019 | 6-26-2 | 1 | |
| 11-0020 | 6-26-8 | 1 | |
| 11-0021 | 6-26-13 | 1 | |
| 11-0026 | 6-26-3 | 1 | 0026-4580 |
| 11-0102 | 6-26-9 | 4 | |
| 11-0105 | 6-26-15 | 1 | |
| 11-0106 | 6-26-23 | 1 | |
| 11-0109 | 6-26-17 | 2 | 0026-4581 |
| 11-0110 | 6-26-10 | 8 | |
| 11-0118 | 6-26-24 | 1 | |
| 11-0119 | 6-26-28 | 1 | |
| 11-0120 | 6-26-22 | 1 | 0026-4074 |
| 11-0122 | 6-26-25 | 1 | |
| 11-0126 | 6-26-11 | 1 | |
| 11-0127 | 6-26-30 | 1 | |
| 11-0130 | 6-26-26 | 1 | |
| 11-0132 | 6-26-6 | 1 | |
| 11-0136 | 6-26-4 | 1 | |
| 11-0138 | 6-26-29 | 1 | |
| 11-0140 | 6-26-18 | 1 | |
| 11-0143 | 6-26-7 | 1 | |
| 11-0144 | 6-26-14 | 1 | |
| 11-0152 | 6-26-31 | 1 | |
| 11-0169 | 6-26-19 | 1 | 0026-4095 |
| 11-0180 | 6-26-27 | 2 | |
| 11-7029 | 6-26-21 | 1 | |
| 11-7054 | 6-26-20 | 1 | 0026-2936 |
| 1106-S | 6-10-1 | 1 | 0026-4272 |
| 11929 | 6-8-10 | 1 | |
| 1492-CD2 | 6-16-12b | 3 | |
| 1492-CD8 | 6-16-12d | 3 | |
| | 6-16-44b | 2 | |
| 1492-F8 | 6-1-13b | 18 | |
| | 6-16-12e | 10 | |
| | 6-16-14b | 2 | |
| | 6-16-44d | 40 | |
| | 6-22-2b | 10 | |
| | 6-22-3b | 2 | |
| | 6-22-4b | 4 | |
| 1492-N1 | 6-1-13a | 1 | |
| | 6-16-12a | 1 | |
| | 6-16-14a | 1 | |
| | 6-16-44a | 1 | |
| | 6-22-2a | 1 | |
| | 6-22-3a | 1 | |
| | 6-22-4a | 2 | |
| 1492-N11 | 6-16-14d | 2 | |
| 1492-N16 | 6-16-12c | 1 | |
| | 6-16-44c | 1 | |

Table 6-2 Alphanumeric Index (Cont'd)

| PART NUMBER | FIGURE & INDEX NUMBER | QTY PER ARTICLE | STOCK OR NATO NUMBER |
|---|---|---|---|
| 1492-N18 | 6-1-13c | 1 | |
| | 6-16-12f | 1 | |
| | 6-16-14c | 1 | |
| | 6-16-44e | 1 | |
| | 6-22-2c | 1 | |
| | 6-22-3c | 1 | |
| | 6-22-4c | 2 | |
| 1492-N2 | 6-1-13d | 2 | |
| | 6-16-12g | 2 | |
| | 6-16-44f | 2 | |
| | 6-22-2d | 2 | |
| | 6-22-3d | 2 | |
| | 6-22-4d | 4 | |
| 1495-G1 | 6-24-1a | 1 | |
| 1495-N12 | 6-16-2a | 1 | |
| | 6-16-3a | 1 | |
| 17-0027 | 6-28-4 | 1 | |
| 1AC2 | 6-16-6 | 1 | |
| 1KS4 | 6-2-4 | 1 | |
| 2006454 | 6-7-20 | 1 | |
| 2006455 | 6-7-4 | 1 | 0026-6228 |
| 2006456 | 6-7-11 | 1 | 0026-6224 |
| 2006457 | 6-7-14 | 1 | 0026-6227 |
| 2006458 | 6-7-17 | 1 | |
| 2006531 | 6-7-2 | 1 | |
| 2006537 | 6-7-9 | 1 | |
| 2009227 | 6-7-10 | 1 | 0026-6223 |
| 2009245 | 6-7-19 | 1 | |
| 22956 | 6-8-11 | 1 | 0026-6206 |
| 23-4043 | 6-21-2 | 1 | |
| 23-4052 | 6-21-5 | 1 | |
| 23-7179 | 6-21-1 | 1 | |
| 24-0191 | 6-28-5 | 1 | |
| 2511 | 6-16-39 | 1 | |
| 25A21 | 6-7-16 | 1 | 0026-6219 |
| 25C385 | 6-7-27 | 1 | 0026-6221 |
| 25C400 | 6-7-22 | 1 | 0026-6220 |
| 25F22 | 6-7-18 | 1 | 0026-6225 |
| 25L27 | 6-7-7 | 1 | 0026-6222 |
| 25L29 | 6-7-3 | 1 | 0026-6218 |
| 26-4301-16P | 6-16-34 | 1 | |
| 26-4301-16S | 6-16-33 | 1 | |
| 27-034-12 | 6-11-4 | 1 | |
| | 6-11-7 | 1 | |
| 27E121 | 6-16-46 | 1 | |
| | 6-22-8 | 1 | |
| 27E122 | 6-16-47 | 1 | |
| 2MV1 | 6-18-1a | 1 | |
| 30-E1-60-E | 6-25-2 | 1 | |
| 30,000.0 | 6-25-11 | 2 | |
| 300U5 | 6-16-43 | 2 | |
| 302-8C-P2-1 | 6-6-3 | 1 | 0026-6246 |
| 31-312 | 6-12-6 | 1 | |
| 31-86 | 6-11-5 | 1 | |
| 31-87 | 6-12-5 | 1 | |
| 33100 | 6-8-5 | 1 | |
| 33101-1/2 | 6-8-9 | 1 | |
| 33217 | 6-8-2 | 1 | |
| 33903 | 6-8-7 | 1 | |
| 33916 | 6-8-4 | 1 | |
| 355-052-00 | 6-21-7 | 1 | |
| 382 | 6-21-6 | 4 | 0026-5186 |
| 3ACA185 | 6-7-8 | 1 | |
| 4-05 | 6-16-19 | 1 | |
| 4-05 | 6-16-20 | 1 | |
| 5000 | 6-16-21a | 1 | |
| 5150 | 6-16-21b | 1 | |
| 6126P81/2 | 6-16-39a | 1 | |
| 646DZE1 | 6-11-1 | 1 | |
| 646GZE11-7011 | 6-12-1 | 1 | |
| 6PA5-EX | 6-14-2 | 1 | |
| 6S6-145V | 6-23-4 | 2 | 6240-2600 |
| 702-COD92 | 6-24-1 | 1 | |
| 709-BOD | 6-16-2 | 1 | |
| | 6-16-3 | 1 | |
| 755 (or 1866) | 6-16-25 | 3 | 0026-6256 |
| 75A115 | 6-7-26 | 4 | |
| 75A5 | 6-7-21 | 4 | |
| 76F54 | 6-7-15 | 1 | |
| 78F5 | 6-7-5 | 1 | 0026-6226 |
| | 6-7-13 | 1 | 0026-6226 |
| 80-026-12 | 6-12-4 | 1 | |
| 800-080-40 | 6-27-4 | 1 | 0026-5184 |
| 800H-W140 | 6-16-28a | 1 | |
| 800T A1A | 6-16-29 | 1 | |
| | 6-16-30 | 1 | |
| | 6-23-8 | 1 | |
| 800T-B2D2 | 6-16-26 | 1 | |
| | 6-16-27 | 1 | |
| 800T-B6D1 | 6-23-9 | 1 | |
| 800T-B6D2 | 6-16-28 | 1 | |
| 800T-H2A4 | 6-23-7 | 1 | |
| 800T-N26G | 6-16-22a | 1 | |
| | 6-16-23a | 1 | |
| 800T-P16 | 6-16-22 | 1 | |
| | 6-16-23 | 1 | |
| 800T-P16R | 6-16-24 | 1 | |
| 800T-X559 | 6-16-22b | 1 | |
| | 6-16-23b | 1 | |
| | 6-16-24a | 1 | |
| | 6-16-26a | 1 | |
| | 6-16-27a | 1 | |
| | 6-16-29a | 1 | |
| | 6-16-30a | 1 | |
| 8262-C73 | 6-9-1 | 1 | |
| 88365 | 6-16-37 | 1 | |
| 88366 | 6-16-36 | 1 | |
| 8PA7-OP | 6-15-2 | 1 | |
| 90AG5 | 6-7-12 | 1 | 0026-6216 |
| 90AH1 | 6-7-6 | 1 | 0026-6217 |
| 97-848 | 6-9-12 | 1 | 0026-6275 |
| A-30 | 6-25-13 | 1 | |
| A13Z250 | 6-16-42 | 2 | |
| A19ABC-24 | 6-20-2 | 1 | |

Table 6-2 Alphanumeric Index (Cont'd)

| PART NUMBER | FIGURE & INDEX NUMBER | QTY PER ARTICLE | STOCK OR NATO NUMBER |
|---|---|---|---|
| ACA-1008 | 6-7-1 | 1 | 0026-6215 |
| ACA1 | 6-7-28 | 1 | |
| ACA9 | 6-7-25 | 1 | |
| AM1-A-3-A-5-2 | 6-16-11 | 2 | |
| AM2-A-3-A-20-2 | 6-16-10 | 1 | |
| AM2-A-3-A-40-2 | 6-16-9 | 1 | |
| AS408A1 | 6-18-1 | 1 | |
| ASA557 | 6-7-23 | 1 | |
| C0613-R138 | 6-22-10 | 1 | |
| C0614-S17 | 6-16-31 | 1 | |
| C0614-S27 | 6-25-1 | 1 | |
| C437E1038 | 6-16-18 | 1 | 0026-2952 |
| CKA-38-70060 | 6-16-4 | 1 | |
| CMU4201 | 6-16-21 | 1 | |
| CT300 | 6-16-38 | 1 | |
| D0613-R137 | 6-22-9 | 1 | |
| D0614-S21 | 6-22-1 | 1 | |
| E121272 115 | 6-19-1 | 1 | |
| EP-70-8C-P4 | 6-6-5 | 1 | 0026-6247 |
| EPR-9-011 | 6-5-9 | 1 | 0026-5148 |
| EX-AR800 | 6-14-1 | 4 | |
| EX-Q800 | 6-15-1 | 1 | |
| FTG13A-600 | 6-20-2a | 1 | |
| H4L510 | 6-2-12 | 1 | 0026-6202 |
| HD2E | 6-16-16 | 1 | |
| HKL-X-20A1 | 6-23-5 | 3 | |
| KUP14A15 | 6-16-5 | 1 | |
| | 6-22-7 | 1 | |
| M20-AES | 6-1-1 | 1 | |
| MDA3501 | 6-16-41 | 1 | |
| MDL-1 | 6-23-6 | 3 | 5920-0530 |
| N-812-1 | 6-3-12 | 2 | 0026-3781 |
| N-813-1 | 6-3-14 | 2 | 0026-2928 |
| N-814-1 | 6-3-13 | 2 | 0026-2931 |
| OT-1025 | 6-25-10 | 1 | |
| SC-7675 | 6-13-16 | 1 | |
| SS-3-16-G | 6-5-8 | 1 | 0026-5146 |
| SS1G-S8 | 6-2-7 | 1 | 0026-5119 |
| SS43-S6 | 6-2-15 | 1 | |
| SS45-S8 | 6-2-6 | 1 | |
| SS45-S8A | 6-2-10 | 1 | |
| | 6-2-17 | 1 | |
| | 6-2-18 | 1 | |
| | 6-2-20 | 1 | |
| SS6C-1-EP | 6-2-8 | 1 | |
| | 6-2-16 | 1 | |
| | 6-2-21 | 1 | |
| UP-1-1-61-142 | 6-16-8 | 1 | |
| V130LA208 | 6-16-45 | 6 | |
| | 6-1-14 | 1 | |
| V180ZA10 | 6-22-6 | 2 | |
| W41 | 6-16-2b | 1 | |
| W61 | 6-16-2b | 1 | |

| PART NUMBER | FIGURE & INDEX NUMBER | QTY PER ARTICLE | STOCK OR NATO NUMBER |
|---|---|---|---|

Table 6-3 Reference Designation Index

| REFERENCE DESIGNATION | FIGURE AND INDEX NUMBER | MFR PART NUMBER |
|---|---|---|
| B1 | 6-16-15 | E121272 115 |
| C1 | 6-16-35 | |
| C2 | 6-16-35 | |
| C3 | 6-16-35 | |
| CB1 | 6-16-8 | UP-1-1-61-142 |
| CB2 | 6-16-9 | AM2-A-3-A-40-2 |
| CB3 | 6-16-10 | AM2-A-3-A-20-2 |
| CB4 | 6-16-11 | AM1-A-3-A-5-2 |
| CB5 | 6-16-11 | AM1-A-3-A-5-2 |
| D1 | 6-16-43 | 300U5 |
| D2 | 6-16-43 | 300U5 |
| D3 | 6-16-41 | MDA3501 |
| DS1 (CAU) | 6-23-4 | 6S6-145V |
| DS1 | 6-16-25 | 755 (or 1866) |
| DS2 (CAU) | 6-23-4 | 6S6-145V |
| DS2 | 6-16-25 | 755 (or 1866) |
| DS3 | 6-16-25 | 755 (or 1866) |
| F1 (CAU) | 6-23-6 | MDL-1 |
| F1 | 6-16-42 | A13Z250 |
| F2 (CAU) | 6-23-6 | MDL-1 |
| F2 | 6-16-42 | A13Z250 |
| F3 (CAU) | 6-23-6 | MDL-1 |
| HR1 (WVH) | 6-25-10 | OT-1025 |
| HR2 (WVH) | 6-25-13 | A-30 |
| K1 (CAU) | 6-24-1 | 702-COD92 |
| K1 | 6-16-2 | 709-BOD |
| K1 (GDS) | 6-21-3 | 0004-5191 |
| K2 (CAU) | 6-22-7 | KUP14A15 |
| K2 | 6-16-3 | 709-BOD |
| K2 (GDS) | 6-21-3 | 0004-5191 |
| K3 (GDS) | 6-21-3 | 0004-5191 |
| K3 | 6-16-4 | CKA-38-70060 |
| K4 | 6-16-5 | KUP14A15 |
| L1 | 6-16-37 | 88365 |
| L2 | 6-9-1 | 8262 C73 |
| M1 | 6-16-20 | 4-05 |
| M2 | 6-16-19 | 4-05 |
| P1 | 6-16-33 | 26-4301-16S |
| P2 | 6-16-34 | 26-4301-16P |
| R3 | 6-16-39 | 2511 |
| R6 | 6-16-21 | CMU4201 |
| RV1 (CAU) | 6-22-6 | V180ZA10 |
| RV1 | 6-16-45 | V130LA208 |
| RV2 (CAU) | 6-22-6 | V180ZA10 |
| RV2 | 6-16-45 | V130LA208 |
| RV3 | 6-16-45 | V130LA208 |
| RV4 | 6-16-45 | V130LA208 |
| RV5 | 6-16-45 | V130LA208 |
| RV6 | 6-16-45 | V130LA208 |
| S1 (CAU) | 6-23-7 | 800T-H2A4 |
| S1 | 6-16-29 | 800T A1A |
| S2 (CAU) | 6-23-8 | 800T-A1A |
| S2 | 6-16-26 | 800T-B2D2 |
| S3 (CAU) | 6-23-9 | 800T-B6D1 |
| S3 | 6-16-30 | 800T A1A |
| S4 | 6-16-27 | 800T-B2D2 |
| S5 | 6-16-28 | 800T-B6D2 |
| S7 | 6-20-2 | A19ABC-24 |
| S8 | 6-16-17 | AS408A1 |
| S9 | 6-16-6 | 1AC2 |
| S10 | 6-16-18 | C437E1038 |
| S11 | 6-2-22 | 646DZE1 |
| S12 | 6-2-23 | 646GZE11-7011 |
| S13 | 6-1-10 | EX-AR800 |
| S14 | 6-1-11 | EX-AR800 |
| S15 | 6-1-12 | EX-AR800 |
| S16 | 6-1-6 | EX-Q800 |
| S17 | 6-1-9 | EX-AR800 |
| T1 (GDS) | 6-21-6 | 382 |
| T1 | 6-16-36 | 88366 |
| T2 | 6-16-16 | HD2E |
| T3 | 6-16-38 | CT300 |
| TB1 | 6-16-12 | |
| TB1 (CAU) | 6-22-2 | |
| TB2 (CAU) | 6-22-3 | |
| TB2 | 6-16-44 | |
| TB3 (CAU) | 6-22-4 | |
| TB3 | 6-16-14 | |
| TB4 (CAU) | 6-22-4 | |
| TB4 | 6-16-13 | |
| TB5 | 6-1-13 | |
| TB6 | 6-16-40 | |
| TH1 (WVH) | 6-25-11 | 30,000.0 |
| TH2 (WVH) | 6-25-11 | 30,000.0 |
| V-1 | 6-2-6 | SS45-S8 |
| V-3 | 6-2-10 | SS45-S8A |
| V-4 | 6-2-15 | SS43-S6 |
| V-6 | 6-2-20 | SS45-S8A |
| V-7 | 6-2-17 | SS45-S8A |
| V-9 | 6-2-18 | SS45-S8A |
| V-15 | 6-2-4 | 1KS4 |
| V-17 | 6-2-7 | SS1G-S8 |
| XDS1 | 6-16-22 | 800T-P16 |
| XDS1 (CAU) | 6-23-2 | 103-3101-1212-403 |
| XDS2 | 6-16-23 | 800T-P16 |
| XDS2 (CAU) | 6-23-3 | 103-3101-1211-403 |
| XDS3 | 6-16-24 | 800T-P16R |
| XF1 (CAU) | 6-23-5 | HKL-X-20A1 |
| XF2 (CAU) | 6-23-5 | HKL-X-20A1 |
| XF3 (CAU) | 6-23-5 | HKL-X-20A1 |
| XK2 (CAU) | 6-22-8 | 27E121 |
| XK3 | 6-16-47 | 27E122 |
| XK4 | 6-16-46 | 27E121 |

CAU - Control/Alarm Unit GDS - Gas Detection System WVH - Wall Vent Heater

# ELECTROLYSER HYDROGEN GENERATOR

| FIG & INDEX NO. | PART NO. | DESCRIPTION | UNITS PER ASSY | AES OR NATO STOCK NUMBER |
|---|---|---|---|---|
| 6-1 1 | M20-AES | . ELECTROLYTIC HYDROGEN GENERATOR (36401) . . . . . | REF | |
| 2 | | . . ELECTRICAL CABINET . . . . . (see figure 6-16 for breakdown) | 1 | |
| 3 | | . . HYDROGEN CELL AREA . . . . . (see figure 6-3 for breakdown) | 1 | |
| 4 | | . . ELECTROLYSER PIPING & COMPRESSOR AREA . . . . . (see figure 6-2 for breakdown) | 1 | |
| 5 | | . . . MANOMETER . . . . . (see figure 6-13 for breakdown) | 2 | |
| 6 | EX-Q800 | . . SWITCH, Compressor inlet valve, Explosion proof CL.1, GR.B,C,D, 1-form C contact, 15A @ 120 Vac contact rating, (09504) S16 (see figure 6-15 for breakdown) | 1 | |
| 7 | | . . JUNCTION BOX, Compressor . . . . . | 1 | |
| 8 | | . . GASHOLDER . . . . . | 1 | |
| 9 | EX-AR800 | . . . SWITCH, Top Limit, Explosion proof CL.1, . . . . . GR.B,C,D, 1-form C contact, 15A @ 120 Vac contact rating, (09504) S17 (see figure 6-14 for breakdown) | 1 | |
| 10 | EX-AR800 | . . . SWITCH, Upper Limit, Explosion proof CL.1, . . . . GR.B,C,D, 1-form C contact, 15A @ 120 Vac contact rating, (09504) S13 (see figure 6-14 for breakdown) | 1 | |
| 11 | EX-AR800 | . . . SWITCH, Lower Limit, Explosion proof CL.1, . . . . GR.B,C,D, 1-form C contact, 15A @ 120 Vac contact rating, (09504) S14 (see figure 6-14 for breakdown) | 1 | |
| 12 | EX-AR800 | . . . SWITCH, Lower Limit, Explosion proof CL.1, . . . . GR.B,C,D, 1-form C contact, 15A @ 120 Vac contact rating, (09504) S15 (see figure 6-14 for breakdown) | 1 | |
| 13 | | . . TERMINAl BLOCK, 'Switch junction box', . . . . . (12277) TB5, consisting of: | 1 | |
| | 1492-N1 | Mounting channel | 1 | |
| | 1492-P8 | Single terminal Block | 18 | |
| | 1492-N18 | End barrier for style F block | 1 | |
| | 1492-N2 | Retaining clip | 2 | |
| -14 | V130LA208 | . . VARISTOR, 'GEMOV', 130V rms, 20 joule, . . . . . (01816) RV6 (mounted across terminals 9 and 12 of TB5) | 6 | |

- Denotes an item not illustrated or not shown as an assembled unit

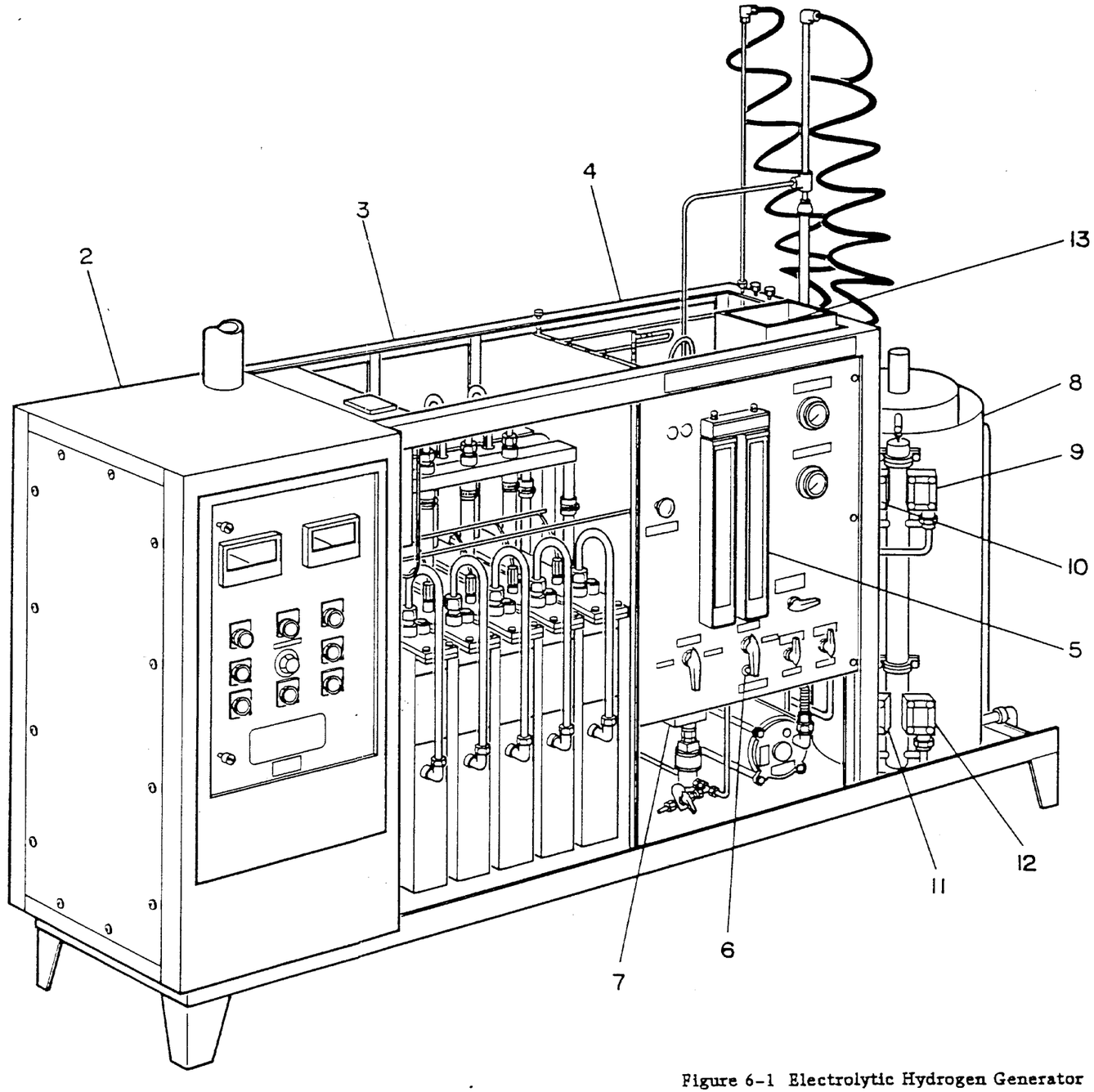



Figure 6-1 Electrolytic Hydrogen Generator

ELECTROLYSER PIPING

| FIG & INDEX NO. | PART NO. | DESCRIPTION | UNITS PER ASSY | AES OR NATO STOCK NUMBER |
|---|---|---|---|---|
| 6-2 1 | | . ELECTROLYSER PIPING | REF | |
| 2 | 103-101 | . . THE CELL ( ) (see figure 6-3 for breakdown | 1 | 0026-6209 |
| 3 | 103-009 | . . TUBE, gas take-off ( ) | 2 | 0026-3353 |
| 4 | 1KS4 | . . VALVE, Hydrogen Sample, (V-15) ( ) | 1 | |
| 5 | 103-019 | . . PIPE, overflow/vent ( ) | 2 | 0026-2917 |
| 6 | SS45-S8 | . . VALVE, Whitey ball valve 3 way, (V-1) (12623) (see figure 6-4 for breakdown) | 1 | |
| 7 | SS1G-S8 | . . VALVE, Whitey toggle valve (V-17) (12623) (see figure 6-5 for breakdown) | 1 | 0026-5119 |
| 8 | SS6C-1-EP | . . VALVE, Check Nupro, (34) (18034) (see figure 6-6 for breakdown) | 1 | |
| 9 | | . . TUBING, Jayon plastic 1/2" I.D., 1 3/4 O.D. | 60" | |
| 10 | SS45-S8A | . . VALVE, Whitey ball valve 2-way (V-3) (12623) (see figure 6-4 for breakdown) | 1 | |
| 11 | ACA 1008 | . . COMPRESSOR, Gardner Denver (08478) (see figure 6-7 for breakdown) | 1 | 0026-6215 |
| 12 | H4L510 | . . BELT, Compressor 1/2" x 51" (11066) | 1 | 0026-6202 |
| 13 | | . . BALSTON FILTER TYPE 33 (51440) (see figure 6-8 for breakdown | 1 | 0026-6211 |
| 14 | 8262-C73 | . . VALVE, Solenoid, Asco, 'Compressor Unloader', 2 way, normally open, 120V, 60 Hz, 1/8 NPT, CL. 1, GR.D, explosion proof, s/st body, 'Buna-N' disc. (04845) L2 (see figure 6-9 for breakdown) | 1 | |
| 15 | SS43-S6 | . . VALVE, Whitey ball valve 2 way (V-4) (12623) (see figure 6-4 for breakdown) | 1 | |
| 16 | SS6C-1-EP | . . VALVE, CHECK, NUPRO (7) (18034) (see figure 6-6 for breakdown) | 1 | |
| 17 | SS45-S8A | . . VALVE, Whitey Ball Valve, 2 way (V-7) (12623) (see figure 6-4 for breakdown | 1 | |
| 18 | SS45-S8A | . . VALVE, Whitey Ball Valve, 2 way, (V-9) (12623) (see figure 6-4 for breakdown) | 1 | |
| 19 | 1106-S | . . PULSATION DAMPENER (38056) (see figure 6-10 for breakdown) | 1 | 0026-4272 |
| 20 | SS45-S8A | . . VALVE, Whitey Ball Valve, 2 way (V-6) (12623) (see figure 6-4 for breakdown) | 1 | |
| 21 | SS6C-1-EP | . . VALVE, Check, NUPRO (25) (18034) (see figure 6-6 for breakdown) | 1 | |
| 22 | 646DZE1 | . . SWITCH, Pressure Differential, 1/4" s/st pressure ports, polyimide diaphragm, 400 PSI max system pressure, explosion proof CL.1, GR.A,B,C,D (09049) S11 (see figure 6-11 for breakdown) | 1 | |
| 23 | 646GZE11-7011 | . . SWITCH, High Pressure, 1/2" s/st pressure port and diaphragm, 18-15 PSI adjustable set point range on increasing pressure, explosion proof CL.1, GR.A,B,C,D (09049) S12 (see figure 6-12 for breakdown (09049) | 1 | |
| 24 | | . . GAUGE, Pressure 0-160 PSI | 3 | 0026-5121 |
| 25 | | . . VALVE, Safety Relief | 1 | |
| -26 | 10AA25WM | . . MANOMETER, U-tube, 6-inch range (39739) (see figure 6-13 for breakdown | 2 | 0026-3362 |
| -27 | C437E1038 | . . SWITCH, Lower Pressure, 'Gasholder pressure', SPST, 120 Vac, 10A, 1/2" 5-1/2" WC set to 1", 1/2" NPT pressure, 1/8" NPT vent (09504) S10 (see figure 6-16 index 18) | 1 | 0026-2952 |
| 28 | | . . GAUGE, Pressure Differential | 1 | |
| 29 | | . MOTOR, Compressor | 1 | |

- Denotes an item not illustrated or not shown as an assembled unit

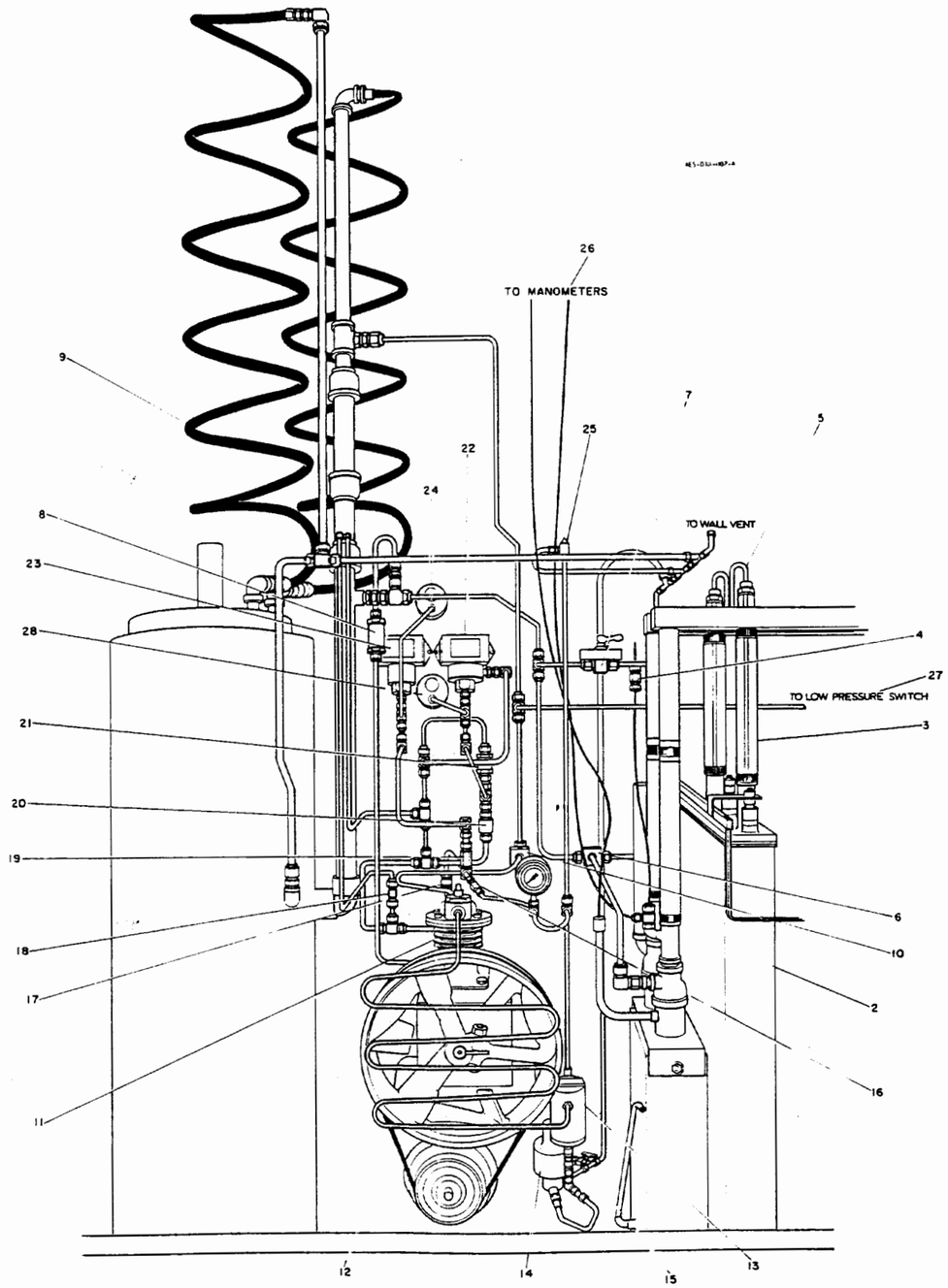
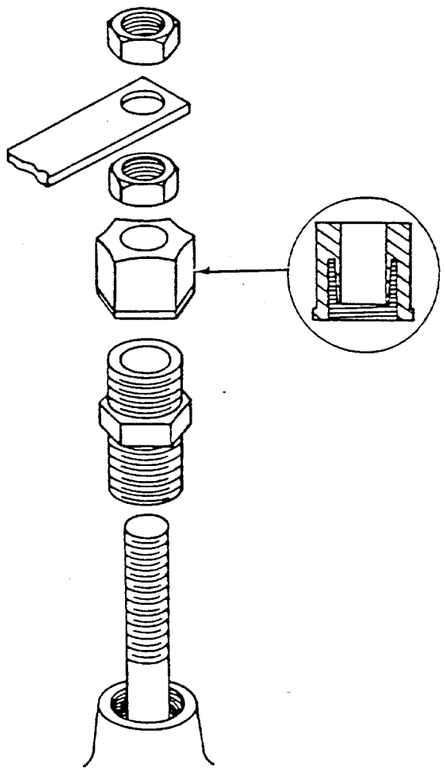



Figure 6-2 Electolyser Piping (Rear View)

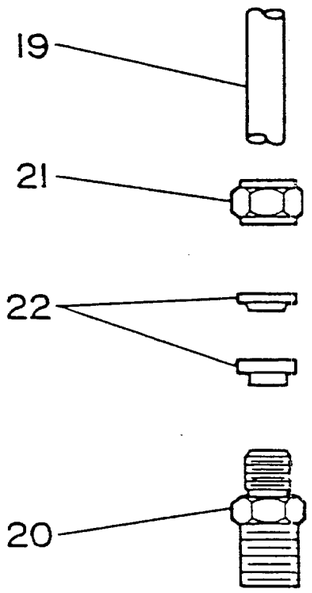
250 AMPERE CELL

| FIG & INDEX NO. | PART NO. | DESCRIPTION . . . . | UNITS PER ASSY | AES OR NATO STOCK NUMBER |
|---|---|---|---|---|
| 6-3 1 | 103-101 | . THE CELL, 250 Ampere (37282) . . . . . | REF | 0026-6209 |
| 2 | 103-102 | . . COVER ASSEMBLY (37282) . . . . . | 1 | |
| | | ATTACHING PARTS | | |
| 3 | 103-112 | . . SCREW, Cap, Hex Head, 1/4-20 x 1" long, Type 18 Stainless Steel (37282) . . . . . | 24 | |
| 4 | 103-105 | . . NUT, Square, 1/4-20 Stainless Steel (37282) . . . . | 24 | |
| | | ---*--- | | |
| 5 | 103-103 | . . GASKET, Tank Cell (37282) . . . . . | 1 | 0026-6207 |
| 6 | 103-104 | . . TANK, Cell (37282) . . . . . | 1 | |
| 7 | 103-109 | . . TERMINAL INSULATOR (37282) (see detail A) . . . . . | 4 | 4730 219048083 |
| 8 | 103-009 | . . TUBE, GAS TAKE-OFF (37282) . . . . . | 2 | |
| 9 | 103-010 | . . CLAMP, Hose (37282) . . . . . | 4 | |
| 10 | 103-011 | . . TUBE, Sight (37282) . . . . . | 1 | 0026-2908 |
| 11 | 103-012 | . . CONNECTOR BODY, 1/2 inch Tubing (37282) . . . . . | 1 | |
| 12 | N-812-1 | . . NUT, 1/2 inch, Swagelok (02570). . . . . | 2 | 0026-3781 |
| 13 | N-814-1 | . . FERRULE, Back, Swagelok, 1/2 inch (02570). . . . . | 2 | 0026-2931 |
| 14 | N-813-1 | . . FERRULE, Front, Swagelok, 1/2 inch (02570) . . . . . | 2 | 0026-2928 |
| 15 | 103-108 | . . ELBOW CONNECTOR BODY 1/2" FEMALE (37282) . . . . . | 1 | |
| 16 | 103-032 | . . PLUG, Pipe, 1/4 inch, Stainless Steel (37282) . . . | 1 | |
| 17 | 103-110 | . . VALVE, Water Feed, Yuasa Type 1/4 inch, -600 SU5316 (37282) . . . . . | 1 | 0026-6203 |
| 18 | | . . CONNECTING HARDWARE, Vent Pipe (see detail B) . . . | 2 | |
| 19 | 103-019 | . . . PIPE, Vent (37282) . . . . . | 2 | |
| 20 | 103-020 | . . . CONNECTOR BODY, 3/8 inch Tubing (37282) . . . . . | 2 | |
| 21 | 103-111 | . . . NUT, Connector Body (37282) . . . . . | 2 | |
| 22 | 103-021 | . . . FERRULE SET, 3/8 inch Tube, Nylon (37282) . . . . | 2 | |
| 23 | 103-027 | . . INSULATOR, Cell (37282) . . . . . | 1 | |
| 24 | 103-113 | . . ANODE (37282) . . . . . | 1 | |
| 25 | 103-114 | . . CATHODE (37282) . . . . . | 1 | |
| 26 | 103-115 | . . DIAPHRAGM (37282) . . . . . | | |
| 27 | 103-116 | . . CLAMP, Strip, Diaphragm, Side (37282) . . . . . | 2 | |
| 28 | 103-117 | . . CLAMP, Strip, Diaphragm, End (37282) . . . . . | 2 | |
| 29 | 103-119 | . . SCREW (37282) . . . . . | 30 | |
| 30 | 103-120 | . . SUPPORT (37282) . . . . . | 4 | |
| 31 | 103-121 | . . SPACER (37282) . . . . . | 1 | |
| 32 | 103-122 | . . SCREW (37282) . . . . . | 1 | |

- Denotes an item not illustrated or not shown as an assembled unit



DETAIL 'A'




DETAIL 'B'

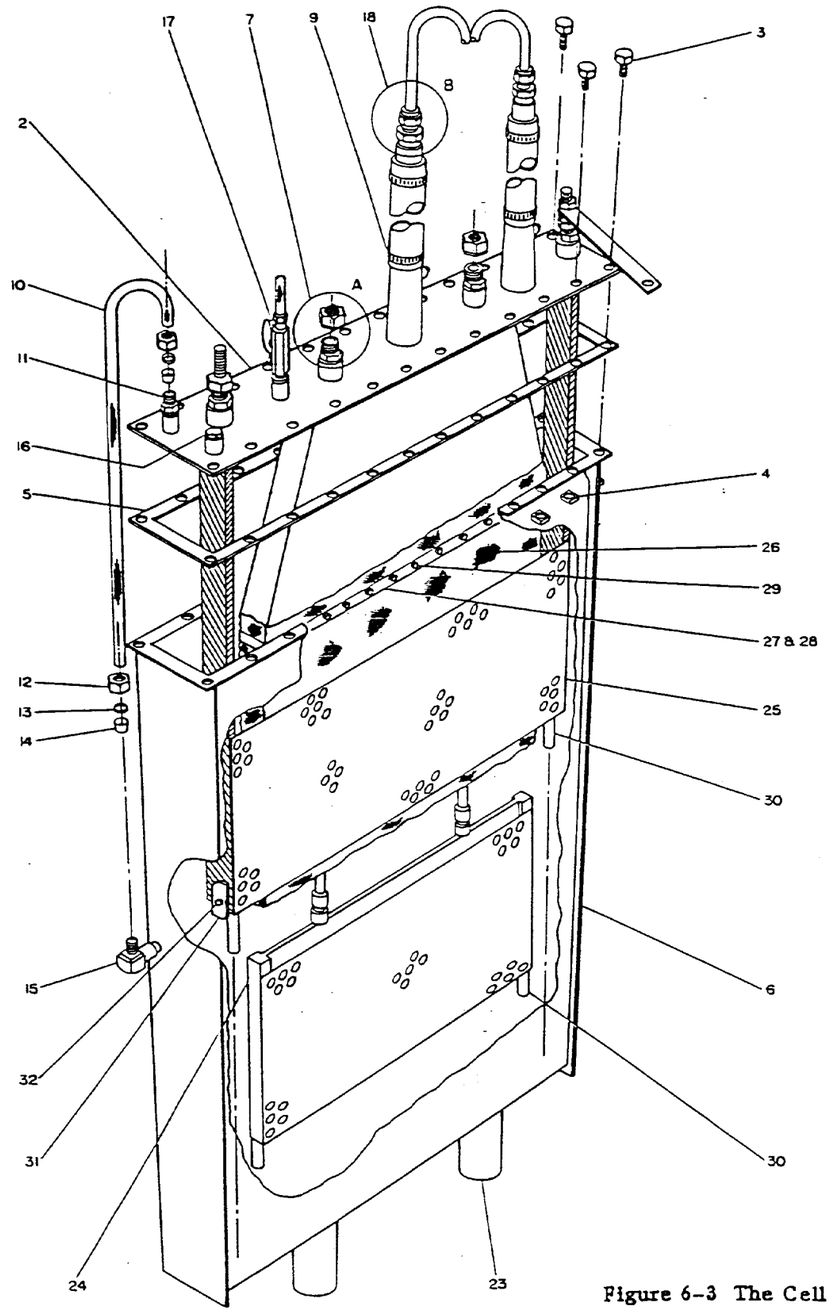



Figure 6-3 The Cell

WHITEY BALL VALVE 3-WAY

| FIG & INDEX NO. | PART NO. | DESCRIPTION . . . . | UNITS PER ASSY | AES OR NATO STOCK NUMBER |
|---|---|---|---|---|
| 6-4 -1 | SS45-S8 | . VALVE, Whitey ball valve, 3 way, V-1 (12623) . . . . . | REF | |
| | SS45-S8A | . VALVE, Whitey ball valve, 2 way, V-3, V-6, V-7, V-9 (12623) . . . | REF | |
| | SS43-S6 | . VALVE, Whitey ball valve, 2 way, V-4 (12623) . . . . . | REF | |
| 2 | | . . SET SCREW . . . . . | 1 | |
| 3 | | . . HANDLE . . . . . | 1 | |
| 4 | | . . PACKING BOLT . . . . . | 1 | |
| 5 | | . . WASHER . . . . . | 1 | |
| 6 | | . . SUPPORT RING . . . . . | 1 | |
| 7 | | . . PACKING . . . . . | 1 | |
| 8 | | . . BALL SEATS . . . . . | 2 | |
| 9 | | . . BALL SEATS . . . . . | 2 | |
| 10 | | . . STEM . . . . . | 1 | |
| 11 | | . . NUT . . . . . | 1 | |
| 12 | | . . BODY . . . . . | 1 | |

- Denotes an item not illustrated or not shown as an assembled unit

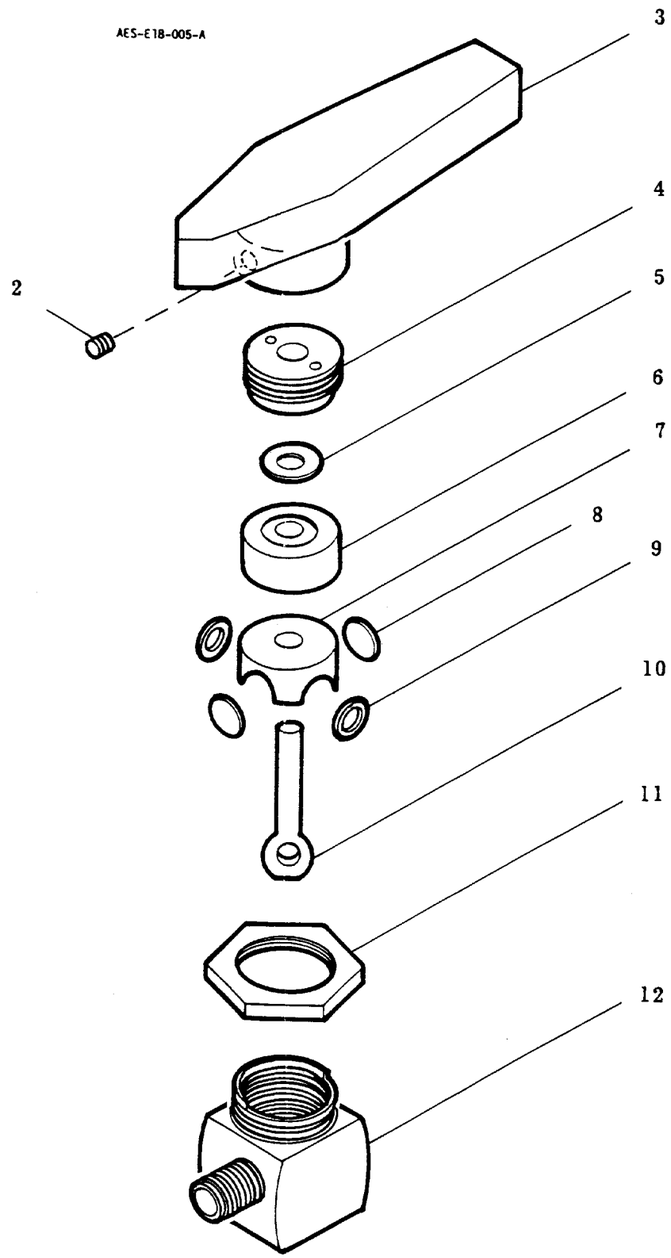



Figure 6-4 Whitey Ball Valve

WHITEY BALL VALVE 3-WAY

| FIG & INDEX NO. | PART NO. | DESCRIPTION . . . . | UNITS PER ASSY | AES OR NATO STOCK NUMBER |
|---|---|---|---|---|
| 6-4 -1 | SS45-S8 | . VALVE, Whitey ball valve, 3 way, V-1 (12623) . . . . . | REF | |
| | SS45-S8A | . VALVE, Whitey ball valve, 2 way, V-3, V-6, V-7, V-9 (12623) . . . | REF | |
| | SS43-S6 | . VALVE, Whitey ball valve, 2 way, V-4 (12623) . . . . . | REF | |
| 2 | | . . SET SCREW . . . . . | 1 | |
| 3 | | . . HANDLE . . . . . | 1 | |
| 4 | | . . PACKING BOLT . . . . . | 1 | |
| 5 | | . . WASHER . . . . . | 1 | |
| 6 | | . . SUPPORT RING . . . . . | 1 | |
| 7 | | . . PACKING . . . . . | 1 | |
| 8 | | . . BALL SEATS . . . . . | 2 | |
| 9 | | . . BALL SEATS . . . . . | 2 | |
| 10 | | . . STEM . . . . . | 1 | |
| 11 | | . . NUT . . . . . | 1 | |
| 12 | | . . BODY . . . . . | 1 | |

- Denotes an item not illustrated or not shown as an assembled unit

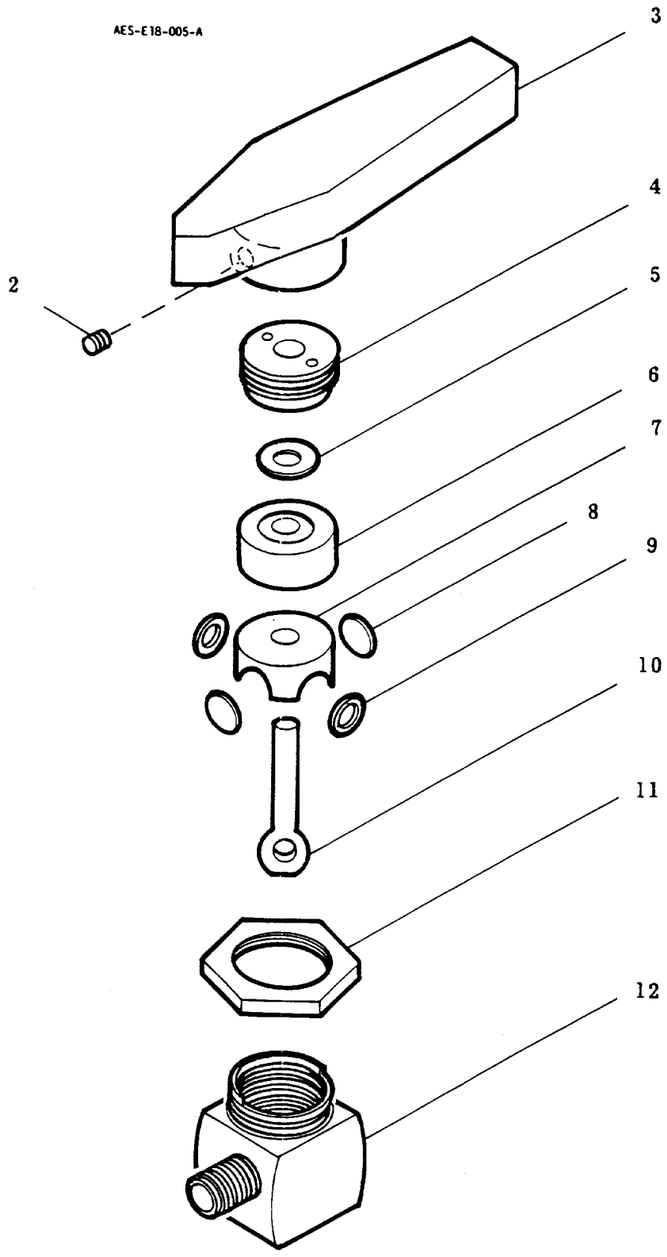



Figure 6-4 Whitey Ball Valve

WHITEY TOGGLE VALVE

| FIG & INDEX NO. | PART NO. | DESCRIPTION | UNITS PER ASSY | AES OR NATO STOCK NUMBER |
|---|---|---|---|---|
| 6-5 -1 | SS1G-S8 | . VALVE, Whitey toggle valve, V-17 (12623) | REF | 0026-5119 |
| 2 | | . . PIN | 1 | |
| 3 | | . . HANDLE | 1 | |
| 4 | | . . WASHER | 1 | |
| 5 | | . . NUT | 1 | |
| 6 | | . . BUSHING | 1 | |
| 7 | | . . SPRING | 1 | |
| 8 | SS-3-16-G | . . STEM, 1/2" (12623) | 1 | 0026-5146 |
| 9 | EPR-9-011 | . . O-RING (12623) | 1 | 0026-5148 |
| 10 | | . VALVE BODY | 1 | |

- Denotes an item not illustrated or not shown as an assembled unit

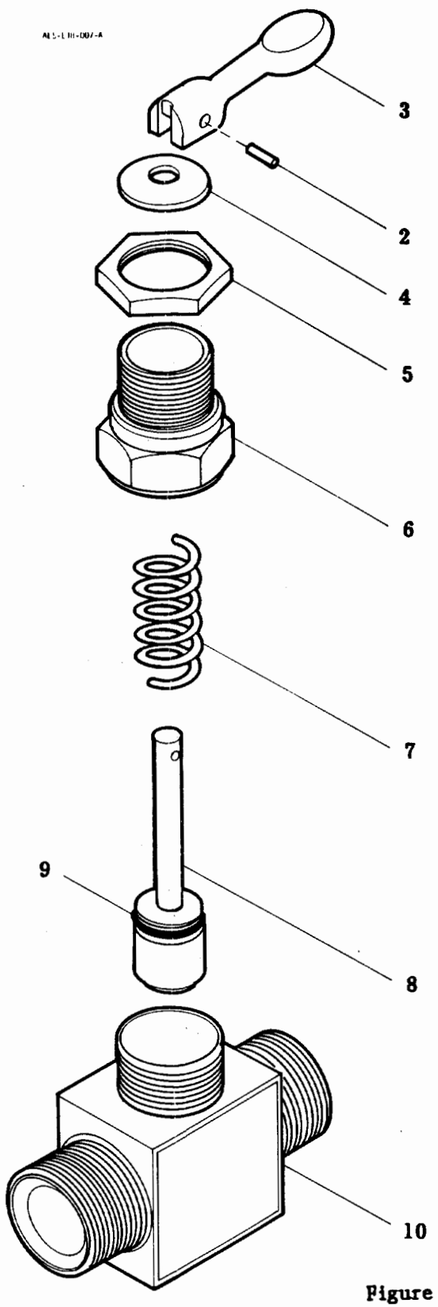



Figure 6-5 Whitey Toggle Valve

NUPRO CHECK VALVE

| FIG & INDEX NO. | PART NO. | DESCRIPTION . . . . | UNITS PER ASSY | AES OR NATO STOCK NUMBER |
|---|---|---|---|---|
| 6-6 -1 | SS6C-1-EP | . CHECK VALVE, Nupro (7, 25, 34) (18034) . . . . . | REF | |
| 2 | | . . BODY, Inner . . . . . | 1 | |
| 3 | 302-8C-P2-1 | . . SPRING (18034) . . . . . | 1 | 0026-6246 |
| 4 | | . . PLUNGER . . . . . | 1 | |
| 5 | EP-70-8C-P4 | . . O-RING (18034) . . . . . | 1 | 0026-6247 |
| 6 | | . . BODY, Outer . . . . . | 1 | |

- Denotes an item not illustrated or not shown as an assembled unit

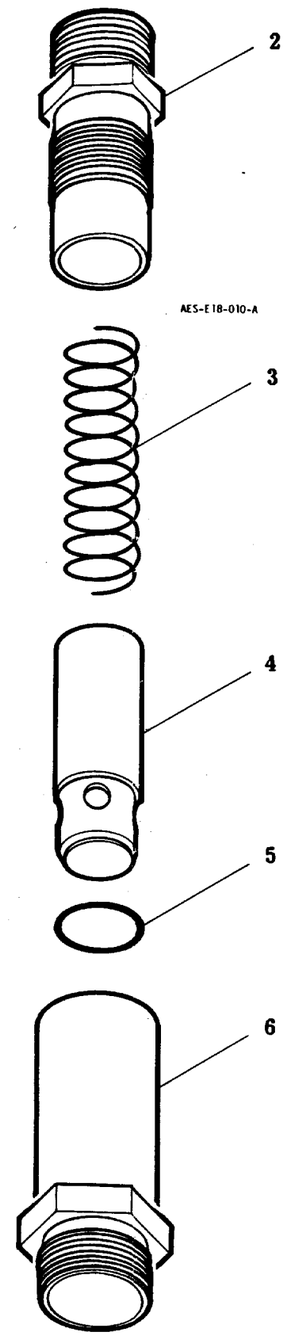



Figure 6-6 Nupro Check Valve

COMPRESSOR, GARDNER DENVER

| FIG & INDEX NO. | PART NO. | DESCRIPTION | UNITS PER ASSY | AES OR NATO STOCK NUMBER |
|---|---|---|---|---|
| 6-7 -1 | ACA-1008 | . COMPRESSOR, Gardner Denver (08478) | REF | 0026-6215 |
| -2 | 2006531 | . . ASM SUCTION VALVE (08478) (items 3-8) | 1 | - |
| 3 | 25L29 | . . . GASKET, Bumper (08478) | 1 | 0026-6218 |
| 4 | 2006455 | . . . BUMPER, Suction Valve (08478) | 1 | 0026-6228 |
| 5 | 78F5 | . . . SPRING, Valve (08478) | 1 | 0026-6226 |
| 6 | 90AH1 | . . . DISC, Valve (08478) | 1 | 0026-6217 |
| 7 | 25L27 | . . . GASKET, Valve Cover (08478) | 1 | 0026-6222 |
| 8 | 3ACA185 | . . . COVER, Plain Valve (08478) | 1 | |
| -9 | 2006537 | . . ASM DISCHARGE VALVE (08478) (items 10-19) | 1 | |
| 10 | 2009227 | . . . GASKET, Valve Seat (08478) | 1 | 0026-6223 |
| 11 | 2006456 | . . . SEAT, Discharge Valve (08478) | 1 | 0026-6224 |
| 12 | 90AG5 | . . . DISC, Valve (08478) | 1 | 0026-6216 |
| 13 | 78F5 | . . . SPRING, Valve (08478) | 1 | 0026-6226 |
| 14 | 2006457 | . . . BUMPER, Discharge Valve (08478) | 1 | 0026-6227 |
| 15 | 76F54 | . . . SET SCREW (08478) | 1 | |
| 16 | 25A21 | . . . GASKET, Valve Cover (08478) | 1 | 0026-6219 |
| 17 | 2006458 | . . . COVER, Discharge Valve (08478) | 1 | |
| 18 | 25F22 | . . . GASKET, Set Screw (08478) | 1 | 0026-6225 |
| 19 | 2009245 | . . . NUT, Set Screw (08478) | 1 | |
| 20 | 2006454 | . . HEAD, Cylinder (08478) | 1 | |
| | | ATTACHING PARTS | | |
| 21 | 75A5 | . . SCREW, Cylinder Head to Cylinder (08478) | 4 | |
| | | ---*--- | | |
| 22 | 25C400 | . . GASKET, Cylinder Head to Cylinder (08478) | 1 | 0026-6220 |
| 23 | ASA557 | . . ASM OIL LEVEL ROD (08478) | 1 | |
| 24 | | . . GASKET | 1 | |
| 25 | ACA9 | . . PLATE, Inspection (08478) | 1 | |
| | | ATTACHING PARTS | | |
| 26 | 75A115 | . . SCREW, Inspection Plate (08478) | 4 | |
| | | ---*--- | | |
| 27 | 25C385 | . . GASKET, Inspection Plate (08478) | 1 | 0026-6221 |
| 28 | ACA1 | . . CRANKCASE (08478) | 1 | |

· Denotes an item not illustrated or not shown as an assembled unit

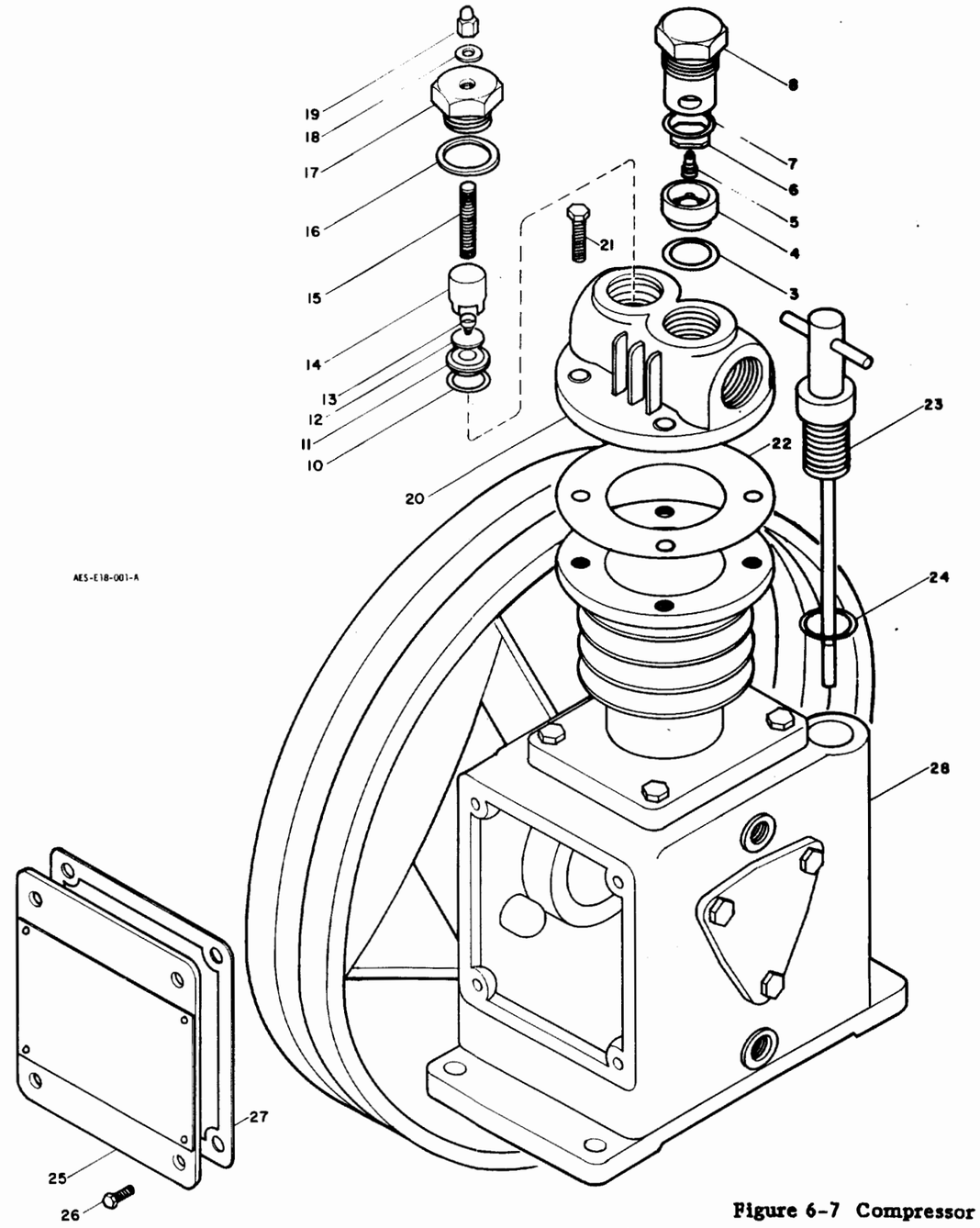



Figure 6-7 Compressor

BALSTON FILTER TYPE 33

| FIG & INDEX NO. | PART NO. | DESCRIPTION . . . . | UNITS PER ASSY | AES OR NATO STOCK NUMBER |
|---|---|---|---|---|
| 6-8 -1 | | . BALSTON FILTER TYPE 33 (51440) . . . . . | REF | 0026-6211 |
| 2 | 33217 | . . NUT, Tie (51440) . . . . . | 1 | |
| 3 | | . . O-RING . . . . . | 1 | |
| 4 | 33916 | . . BASE (51440) . . . . . | 1 | |
| 5 | 33100 | . . BOWL (51440) . . . . . | 1 | |
| 6 | | . . GASKET . . . . . | 2 | |
| 7 | 33903 | . . RETAINER, Element (51440) . . . . . | 1 | |
| 8 | 100-12DX | . . TUBE, Filter (51440) . . . . . | 1 | 0026-5181 |
| 9 | 33101-1/2 | . . HEAD (51440) . . . . . | 1 | |
| 10 | 11929 | . . PLUG 1/8 inch (51440) . . . . . | 1 | |
| -11 | 22956 | . . SEAL SET, Teflon (items 3 and 6) (51440) . . . . . | 1 | 0026-6206 |

- Denotes an item not illustrated or not shown as an assembled unit

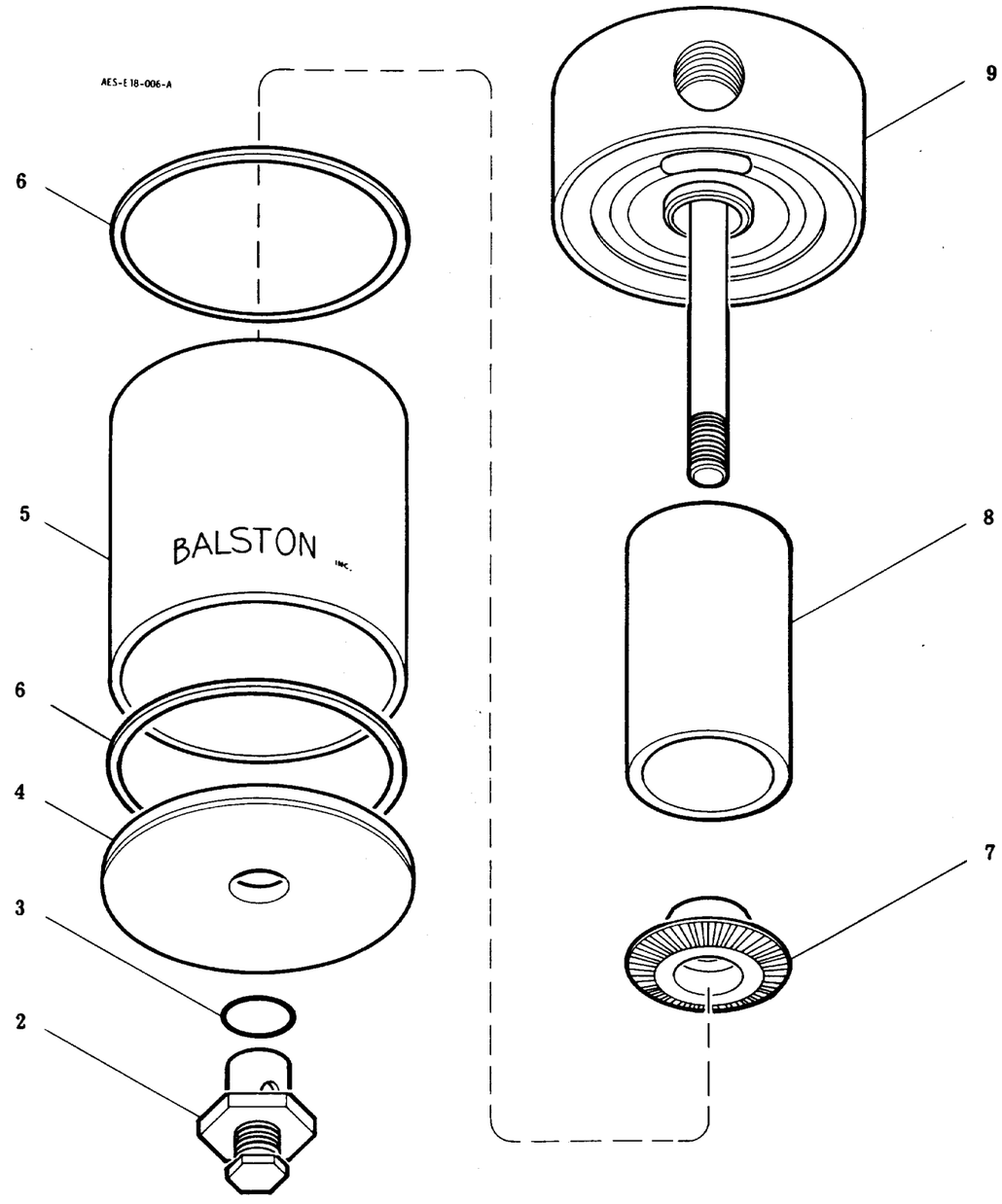



Figure 6-8 Balston Filter

SOLENOID VALVE

| FIG & INDEX NO. | PART NO. | DESCRIPTION | UNITS PER ASSY | AES OR NATO STOCK NUMBER |
|---|---|---|---|---|
| 6-9 -1 | 8262-C73 | . SOLENOID VALVE (04845) | REF | |
| 2 | | . . CAP, End | 1 | |
| 3 | | . . SPRING, Disc | 1 | |
| 4 | | . . DISC | 1 | |
| 5 | | . . HOLDER, Disc | 1 | |
| 6 | | . . O-RING | 1 | |
| 7 | | . . BODY, Valve | 1 | |
| 8 | | . . O-RING | 1 | |
| 9 | | . . CORE ASSEMBLY | 1 | |
| 10 | | . . SPRING, Core | 1 | |
| 11 | | . . COIL | 1 | |
| -12 | 97-848 | . . REPAIR KIT (04845) (consists of item No's 3, 4, 5, 6, 8, 9 and 10) | REF | 0026-6275 |

- Denotes an item not illustrated or not shown as an assembled unit

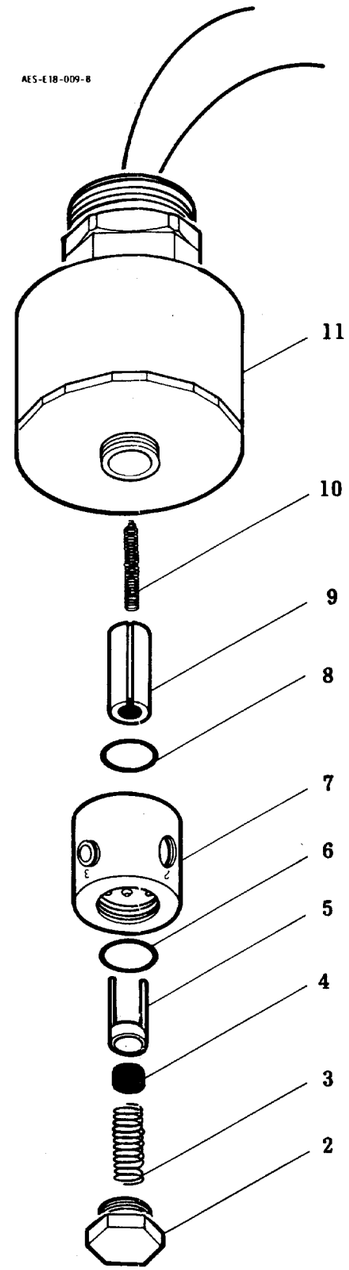



Figure 6-9 Solenoid Valve

ASHCROFT PULSATION DAMPNER

| FIG & INDEX NO. | PART NO. | DESCRIPTION . . . . | UNITS PER ASSY | AES OR NATO STOCK NUMBER |
|---|---|---|---|---|
| 6-10 -1 | 1106S | . ASHCROFT PULSATION DAMPNER (38056) . . . . . | REF | 0026-4272 |
| 2 | | . . SCREW, Retaining . . . . . | 1 | |
| 3 | | . . PLUNGER . . . . . | 1 | |
| 4 | | . . DISC, Sealing . . . . . | 1 | |
| 5 | | . . BUSHING . . . . . | 1 | |
| 6 | | . . BODY, Valve . . . . . | 1 | |

- Denotes an item not illustrated or not shown as an assembled unit

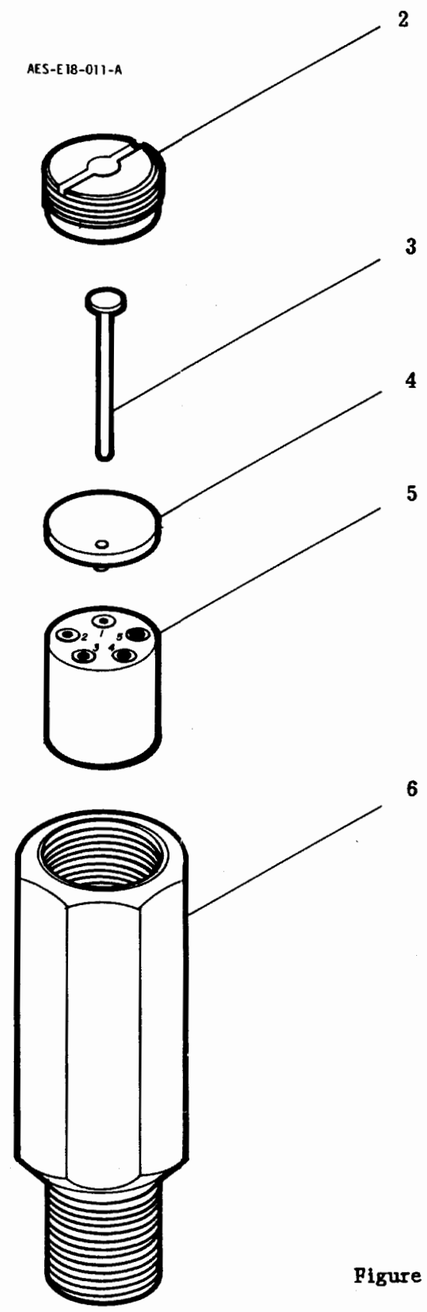



Figure 6-10 Pulsation Dampener

PRESSURE DIFFERENTIAL SWITCH

| FIG & INDEX NO. | PART NO. | DESCRIPTION | UNITS PER ASSY | AES OR NATO STOCK NUMBER |
|---|---|---|---|---|
| 6-11 -1 | 646DZE1 | . PRESSURE DIFFERENTIAL SWITCH, 1/4" s/st pressure . . . ports, polyimide diaphragm, 400 PSI max system pressure, explosion proof CL.1, GR.A,B,C,D (09049) S11 | REF | |
| 2 | | . . CAP | 1 | |
| | | ATTACHING PARTS | | |
| 3 | | . . SCREW | 8 | |
| | | ---*--- | | |
| 4 | 27-034-12 | . . GASKET (09049) | 1 | |
| 5 | 31-86 | . . DIAPHRAGM (09049) | 1 | |
| 6 | | . . PLATE, Actuation | 1 | |
| 7 | 27-034-12 | . . GASKET (09049) | 1 | |
| 8 | | . . COVER | 1 | |
| | | ATTACHING PARTS | | |
| 9 | | . . SCREW, Captive | 4 | |
| | | ---*--- | | |
| 10 | | . . GASKET | 1 | |
| 11 | | . . BODY, Switch | 1 | |

- Denotes an item not illustrated or not shown as an assembled unit

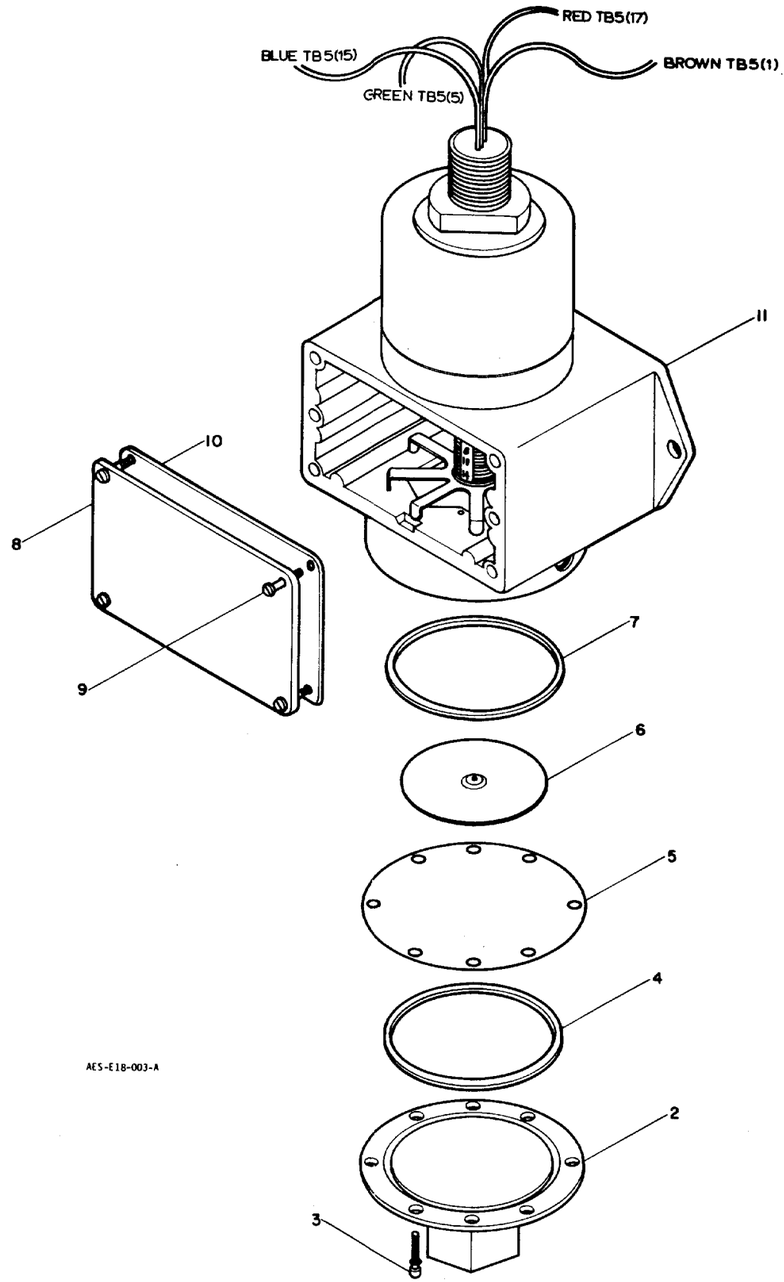



Figure 6-11 Pressure Differential Switch

HIGH PRESSURE SWITCH, CCS

| FIG & INDEX NO. | PART NO. | DESCRIPTION . . . . | UNITS PER ASSY | AES OR NATO STOCK NUMBER |
|---|---|---|---|---|
| 6-12 -1 | 646GZE11-7011 | . SWITCH, High Pressure, 1/2" s/st pressure port and diaphragm, 18-15 PSI adjustable set point range on increasing pressure, explosion proof CL.1, GR.A,B,C,D (09049) S12 | REF | |
| 2 | | . . CAP | 1 | |
| | | ATTACHING PARTS | | |
| 3 | | . . SCREW | 6 | |
| | | ---*--- | | |
| 4 | 80-026-12 | . . O-RING (09049) | 1 | |
| 5 | 31-87 | . . DIAPHRAGM, Plastic (09049) | 1 | |
| 6 | 31-312 | . . DIAPHRAGM, Aluminium (09049) | 1 | |
| 7 | | . . RING | 1 | |
| 8 | | . . DISC, Spring | 1 | |
| 9 | | . . PLATE | 1 | |
| | | ATTACHING PARTS | | |
| 10 | | . . SCREW | 6 | |
| | | ---*--- | | |
| 11 | | . . GASKET | 1 | |
| 12 | | . . COVER | 1 | |
| | | ATTACHING PARTS | | |
| 13 | | . . SCREW, Captive | 4 | |
| | | ---*--- | | |
| 14 | | . . GASKET | 1 | |
| 15 | | . . BODY, Switch | 1 | |

- Denotes an item not illustrated or not shown as an assembled unit

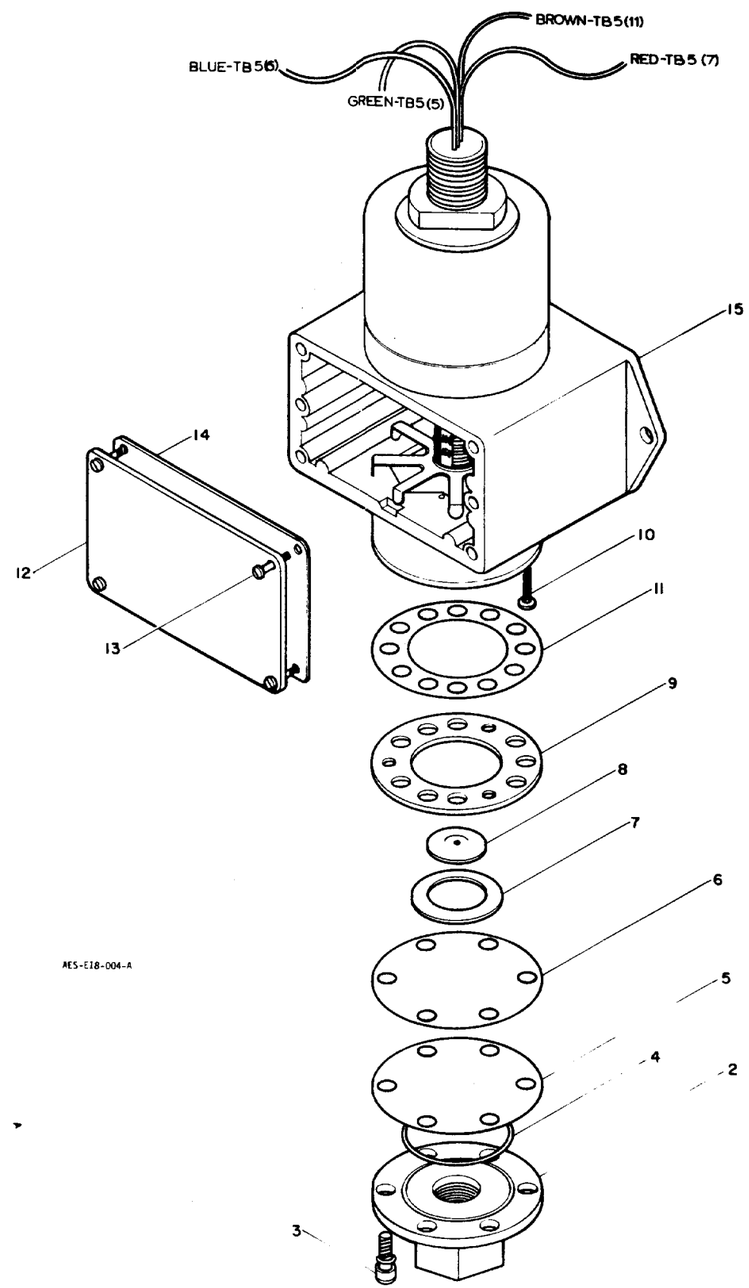



Figure 6-12 High Pressure Switch

MANOMETER

| FIG & INDEX NO. | PART NO. | DESCRIPTION | UNITS PER ASSY | AES OR NATO STOCK NUMBER |
|---|---|---|---|---|
| 6-13 -1 | 10AA25WM | . MANOMETER, U-type, 6 inch range (39739) | REF | 0026-3362 |
| 2 | | . . BLOCK, Upper Manifold | 1 | |
| 3 | | . . CONNECTOR, Male, Swagelok | 1 | |
| 4 | | . . NUT, cap | 1 | |
| 5 | | . . NUT, Hex | 1 | |
| 6 | | . . STUD, Threaded | 1 | |
| 7 | | . . WASHER | 2 | |
| 8 | | . . SCALE | 1 | |
| | | ATTACHING PARTS | | |
| 9 | | . . SPACER | 2 | |
| 10 | | . . WASHER | 2 | |
| 11 | | . . SCREW | 2 | |
| | | ---*--- | | |
| 12 | | . . TUBE | 1 | |
| | | ATTACHING PARTS | | |
| 13 | | . . CLAMP | 1 | |
| 14 | | . . SCREW | 1 | |
| | | ---*--- | | |
| 15 | | . . BLOCK, Lower Retainer | 1 | |
| 16 | SC-7675 | . . Body (39739) | 1 | |
| | | ATTACHING PARTS | | |
| 17 | | . . SCREW | 2 | |
| 18 | | . . WASHER | 2 | |
| 19 | | . . NUT, Hex | 3 | |
| | | ---*--- | | |

- Denotes an item not illustrated or not shown as an assembled unit

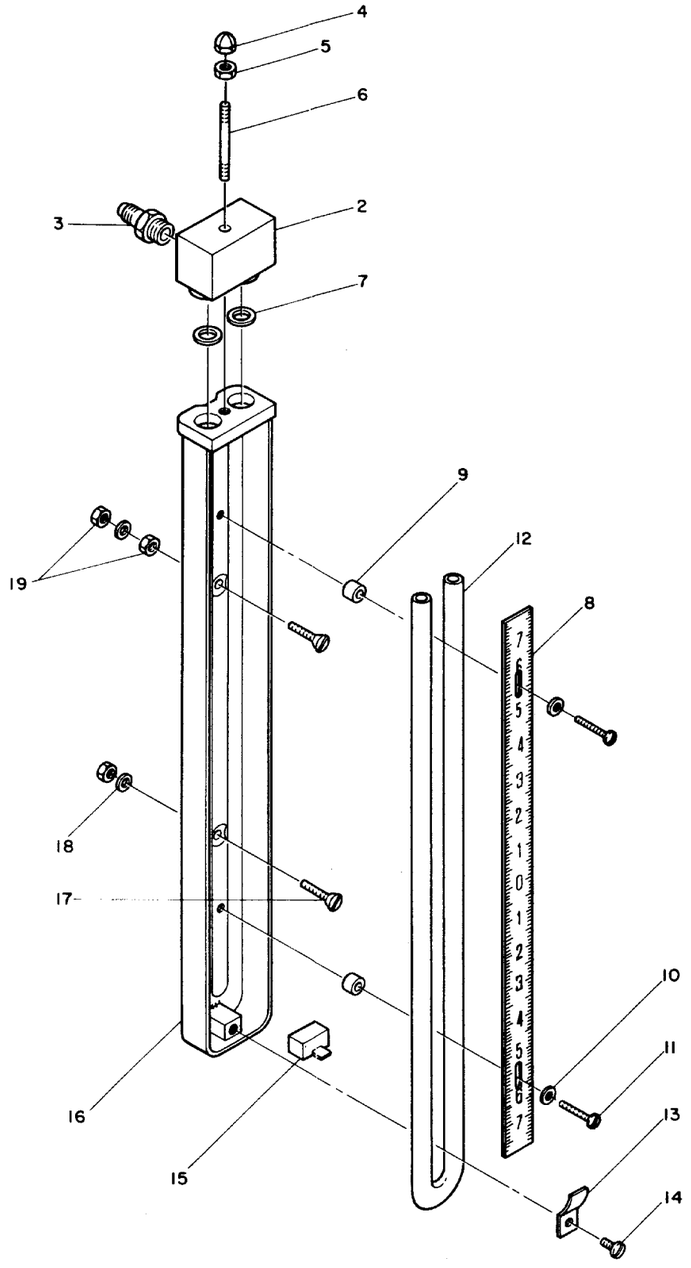
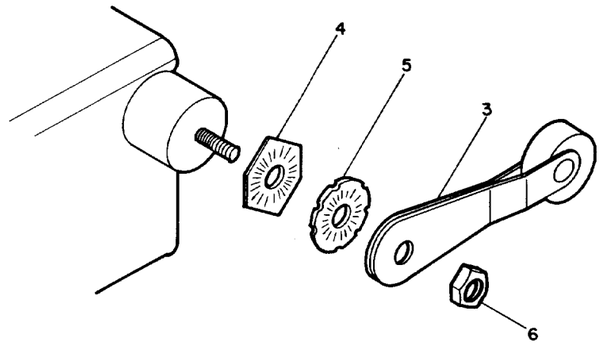



Figure 6-13 Manometer U-Tube

UPPER & LOWER LIMIT SWITCH ASSEMBLIES

| FIG & INDEX NO. | PART NO. | DESCRIPTION | UNITS PER ASSY | AES OR NATO STOCK NUMBER |
|---|---|---|---|---|
| 6-14 -1 | EX-AR800 | . SWITCH ASSEMBLY, Upper & Lower Limit, Explosion proof CL.1, GR.B,C,D, 1-form C contact, 15A @ 120 Vac contact rating, (09504) S13, S14, S15, S17 | REF | |
| -2 | 6PA5-EX | . . EXTERNAL ACTUATOR, Rotary (09504) | 1 | |
| 3 | | . . . LEVER | 1 | |
| | | ATTACHING PARTS | | |
| 4 | | . . . WASHER, Hexagon | 1 | |
| 5 | | . . . WASHER, Fluted | 1 | |
| 6 | | . . NUT, Lock | 1 | |
| | | ---*--- | | |
| 7 | | . . COVER PLATE | 1 | |
| | | ATTACHING PARTS | | |
| 8 | | . . SCREW | 4 | |
| | | ---*--- | | |
| 9 | | . . BODY, Switch | 1 | |

Denotes an item not illustrated or not shown as an assembled unit



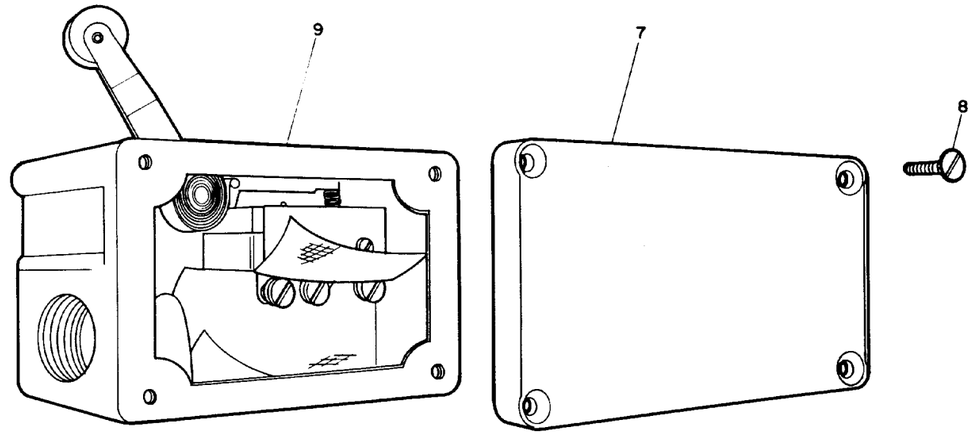




Figure 6-14 Upper & Lower Limit Switches

COMPRESSOR INLET SWITCH ASSEMBLY

| FIG & INDEX NO. | PART NO. | DESCRIPTION | UNITS PER ASSY | AES OR NATO STOCK NUMBER |
|---|---|---|---|---|
| 6-15 -1 | EX-Q800 | . SWITCH ASSEMBLY, Compressor inlet valve, Explosion proof CL.1, GR.B,C,D, 1-form C contact, 15A @ 120 Vac contact rating, (09504) S16 | REF | |
| -2 | 8PA7-0P | . . EXTERNAL ACTUATOR, Plunger (09054) | 1 | |
| 3 | | . . . RING, Lock | 1 | |
| 4 | | . . . BUSHING | 1 | |
| 5 | | . . . PLUNGER | 1 | |
| 6 | | . . . WASHER, Lock | 1 | |
| 7 | | . . . ROD | 1 | |
| 8 | | . . . BUSHING | 1 | |
| 9 | | . . . SPRING | 1 | |
| 10 | | . . COVER PLATE | 1 | |
| | | ATTACHING PARTS | | |
| 11 | | . . SCREW | 4 | |
| | | ---*--- | | |
| 12 | | . . BODY, Switch | 1 | |

- Denotes an item not illustrated or not shown as an assembled unit

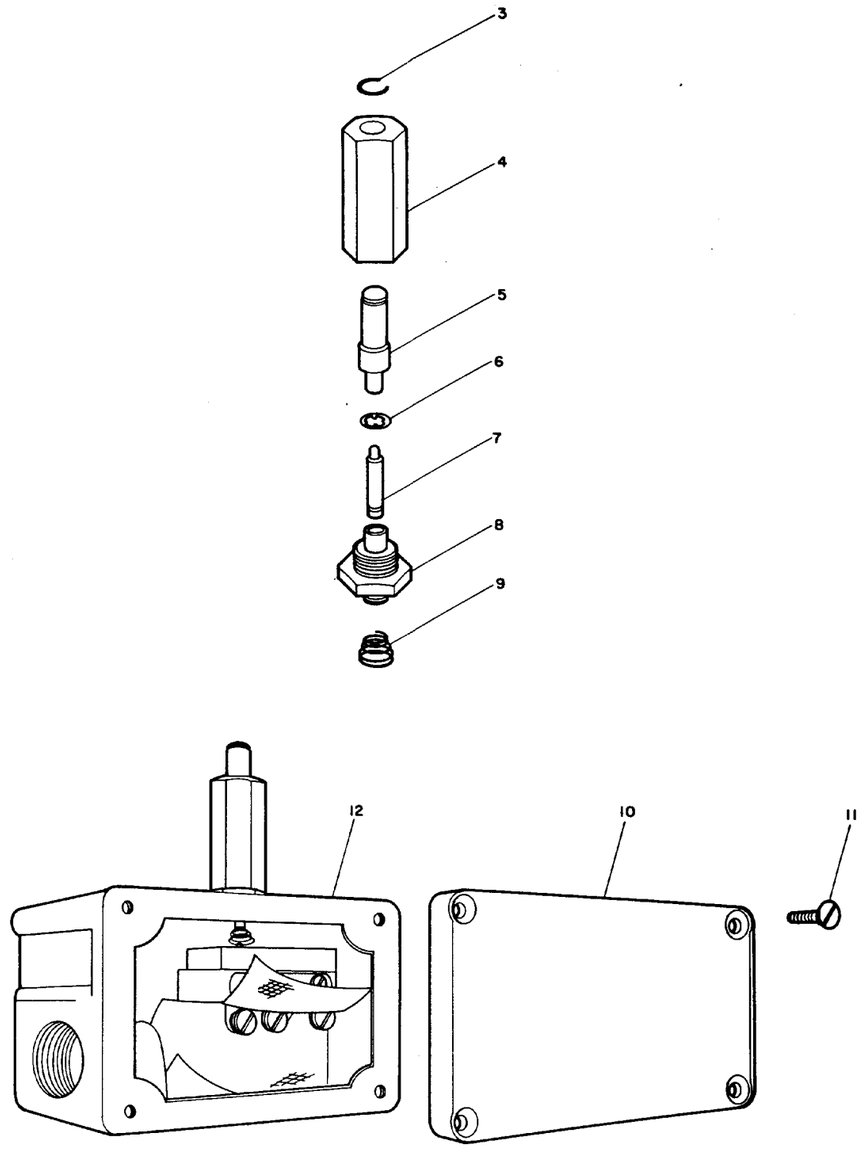



Figure 6-15 Compressor Inlet Switch

ELECTRICAL CABINET

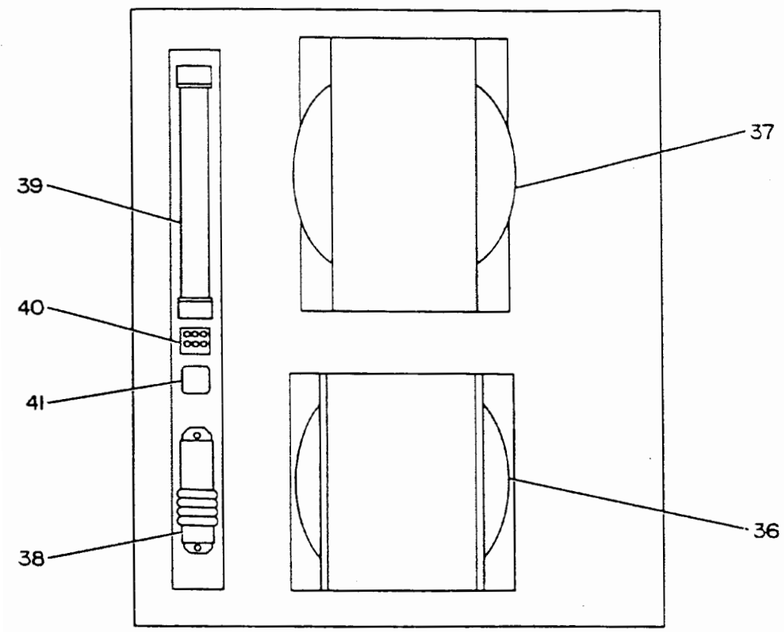
| FIG & INDEX NO. | PART NO. | DESCRIPTION . . . . | UNITS PER ASSY | AES OR NATO STOCK NUMBER |
|---|---|---|---|---|
| 6-16 -1 | | . ELECTRICAL CABINET . . . . . | REF | |
| 2 | 709-B0D | . . RELAY, Magnetic Starter, Size 1, 3 pole, 120V, . . . 60 Hz, 2 overload relays (3rd removed) (12277) K1 | 2 | |
| | 1495-N12 | c/w auxiliary contact, 1 N.O. | | |
| | W61 | c/w 30 Amp heater element | | |
| 3 | 709-B0D | . . RELAY, Magnetic Starter, Size 1, 3 pole, 120V, . . . 60 Hz, 2 overload relays (3rd removed) (12277) K2 | 2 | |
| | 1495-N12 | c/w auxiliary contact, 1 N.O. | | |
| | W41 | c/w 10 Amp heater element | | |
| 4 | CKA-38-70060 | . . RELAY, Time Delay, 1 minute fixed on operate, . . . 120V, 60 hz, (12300) K3 | 1 | |
| 5 | KUP14A15 | . . RELAY, 'H.P. Sw Aux', 3 PDT, 120V, 10A, 60Hz, . . . (12300) K4 | 1 | |
| 6 | 1AC2 | . . SWITCH, 'Maintenance', 1-form C contact, 15A, . . . @ 120 Vac, contact rating style 1, (09504) S9 | 1 | |
| 7 | A19ABC-24 | . . SWITCH, Thermostat, 'Room cold', SPDT,120V, 16A, . . -30° to 100°F, set at 40°F, 1-FORM C contact, (31626) S7 (see figure 6-20) | 1 | |
| | FTG13A-600 | c/w packing nut | | |
| 8 | UP-1-1-61-142 | . . CIRCUIT BREAKER, 1 pole. 1.25A. 120V, 60 Hz, . . . . type UP, series trip, delay curve 1, Hermetically sealed, (81541) CB1 | 1 | |
| 9 | AM2-A-3-A-40-2 | . . CIRCUIT BREAKER, 2 pole, 40A, 120V, 60 Hz. . . . . Companion trip, Magnetic hydraulic type (74193) CB2 | 1 | |
| 10 | AM2-A-3-A-20-2 | . . CIRCUIT BREAKER, 2 pole, 20A, 120V, 60 Hz, . . . . . magnetic hydraulic type (74193) CB3 | 1 | |
| 11 | AM1-A-3-A-5-2 | . . CIRCUIT BREAKER, 1 pole, 5A, 120V, 60 Hz, . . . . . magnetic hydraulic type (74193) CB4, CB5 | 2 | |
| 12 | | . . TERMINAL BLOCK, 16-terminal, 'External . . . . . connections', (12277) TB1, consisting of: | 1 | |
| | 1492-N1 | Mounting channel | 1 | |
| | 1492-CD2 | Single terminal block | 3 | |
| | 1492-N16 | End barrier for CD block | 1 | |
| | 1492-CD8 | Single terminal block | 3 | |
| | 1492-F8 | Single terminal Block | 10 | |
| | 1492-N18 | End barrier for style F block | 1 | |
| | 1492-N2 | Retaining clip | 2 | |
| 13 | | . . TERMINAL BOARD, 6-terminal, 'Ground bus', . . . . . copper, TB4 | 1 | |
| 14 | | . . TERMINAL BOARD, 2-terminal, 'Fan motor', . . . . . (12277) TB3, consisting of: | 1 | |
| | 1492-N1 | Mounting channel | 1 | |
| | 1492-F8 | Single terminal Block | 2 | |
| | 1492-N18 | End barrier for style F block | 1 | |
| | 1492-N11 | End anchor | 2 | |
| 15 | E121272 115 | . . MOTOR, Fan, 120v, 60 Hz, 1.3A, 1290/1550 RPM . . . . (02324) B1 (see figure 6-19) | 1 | |
| 16 | HD2E | . . TRANSFORMER, 'Annunciator', single phase, . . . . . 120V pri, 12V sec, 25VA (73831) T2 | 1 | |
| 17 | AS408A1 | . . SWITCH, Mercury, clip and sail, 'Wind' . . . . . (09504) S8 (see figure 6-18) | 1 | |
| | 2MV1 | (Modified by Electrolyser (37282) | | |
| 18 | C437E1038 | . . SWITCH, Lower Pressure, 'Gasholder pressure', . . . SPST, 120 Vac, 10A, 1/2" 5-1/2" WC set to 1", 1/2" NPT pressure, 1/8" NPT vent (09504) S10 | 1 | 0026-2952 |
| 19 | 4-05 | . . VOLTMETER, 0-20 Vdc (06555) M2 . . . . . | 1 | |
| 20 | 4-05 | . . AMMETER, 50 mV, dc shunt rated, 0-300 Adc scale . . (06555) M1 | 1 | |

ELECTRICAL CABINET (Cont'd)

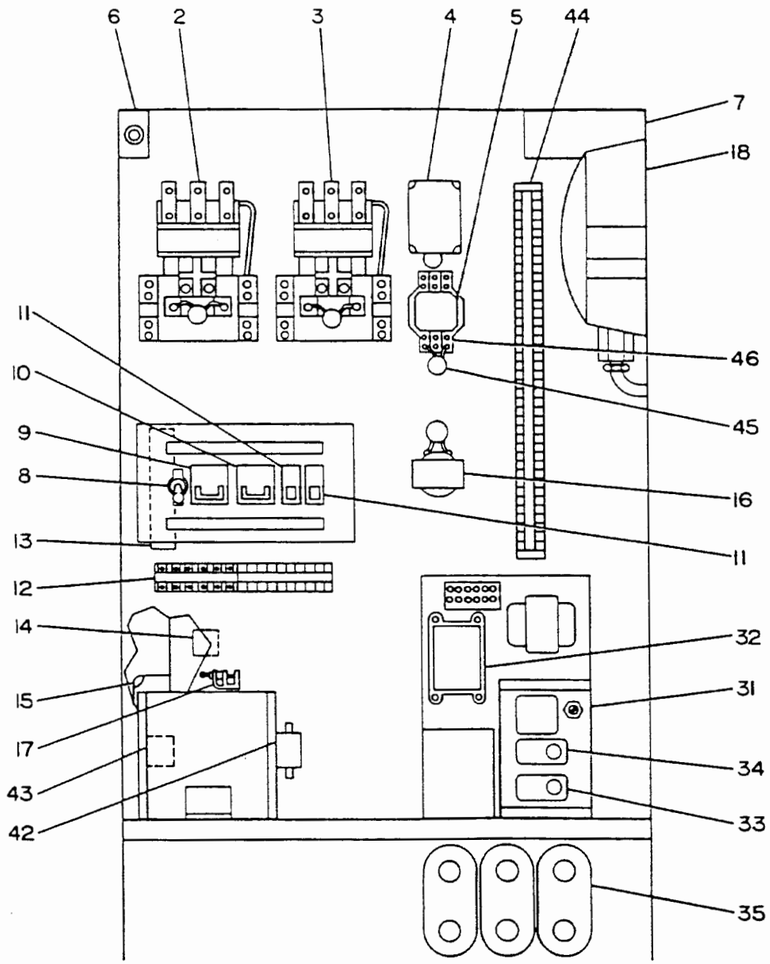
| FIG & INDEX NO. | PART NO. | DESCRIPTION | UNITS PER ASSY | AES OR NATO STOCK NUMBER |
|---|---|---|---|---|
| 6-16 21 | CMU4201 | . . RESISTOR. Variable, carbon, 2W, (44655) R6 . . . . | 1 | |
| | 5000 | c/w dial 2-3/16" dia. | | |
| | 5150 | c/w knob | | |
| 22 | 800T-P16 | . . HOLDER, Indicator Lamp, Transformer type, . . . . . 120:6.3V, 60 Hz, oiltight, (12277) XDS1 | 1 | |
| | 800T-N26G | c/w green lens | | |
| | 800T-X559 | c/w legend plate, type 13, gray, engraved 'RECTIFIER ON' | | |
| 23 | 800T-P16 | . . HOLDER, Indicator Lamp, Transformer type, . . . . . 120:6.3V, 60 Hz, oiltight, (12277) XDS2 | 1 | |
| | 800T-N26G | c/w green lens | | |
| | 800T-X559 | c/w legend plate, type 13, gray, engraved 'COMPRESSOR ON' | | |
| 24 | 800T-P16R | . . HOLDER, Indicator Lamp, Transformer type, . . . . . 120:6.3V, 60 Hz, Red lens, oiltight, (12277) XDS3 | 1 | |
| | 800T-X559 | c/w legend plate, type 13, gray, engraved 'OVERLOAD' | | |
| 25 | 755 (or 1866) | . . LAMP, Indicator, 6.3 Vac, 60Hz, 50,000 hr life . . . . (09819) DS1, DS2, DS3 | 3 | |
| 26 | 800T-B2D2 | . . SWITCH, pushbutton, black extended head, 1-NC . . . momentary contact (12277) S2 | 1 | |
| | 800T-X559 | c/w gray legend plate, type 13, engraved 'RECTIFIER STOP' | | |
| 27 | 800T-B2D2 | . . SWITCH, pushbutton, black extended head, 1-NC . . . momentary contact (12277) S4 | 1 | |
| | 800T-X559 | c/w gray legend plate, type 13, engraved 'COMPRESSOOR STOP' | | |
| 28 | 800T-B6D2 | . . SWITCH, pushbutton, red extended head, 1-NC . . . sealed contact (12277) S5 | 1 | |
| | 800H-W140 | c/w red legend plate, type 4X, engraved 'EMERGENCY OFF' | | |
| 29 | 800T A1A | . . SWITCH, pushbutton, Green flush head, 1-NO, . . . . 1-NC, momentary contacts, (12277) S1 | 2 | |
| | 800T-X559 | c/w gray legend plate, type 13, engraved 'RECTIFIER START' | | |
| 30 | 800T A1A | . . SWITCH, pushbutton, Green flush head, 1-NO, . . . . 1-NC, momentary contacts, (12277) S3 | 2 | |
| | 800T-X559 | c/w gray legend plate, type 13, engraved 'COMPRESSOR START' | | |
| 31 | C0614-S17 | . . CONTROL MODULE, Modified by AES (36401) . . . . . | 1 | |
| 32 | 102035 | . . . REGULATOR, Electrolyser (37282) . . . . . (see figure 6-17) | 1 | |
| 33 | 26-4301-16S | . . CONNECTOR, 16 terminal, 'Blue Ribbon', Cable . . . . Clamp on top (03554) P1 | 2 | |
| 34 | 26-4301-16P | . . CONNECTOR, 16 terminal, 'Blue Ribbon', Cable . . . . Clamp on top (03554) P2 | 2 | |
| 35 | | . . CAPACITOR UNIT, 460 Vac, 40 ufd, c/w 47OK . . . . . resistors & mounting brackets C1, C2, C3 | 3 | |
| 36 | 88366 | . . TRANSFORMER, Rectifier, 188V pri, 28V sec CT . . . . @ 210A (73831) T1 | 1 | |
| 37 | 88365 | . . REACTOR, Saturable, (73831) L1 . . . . . | 1 | |
| 38 | CT300 | . . TRANSFORMER, Current, 300:5 amp ratio, 1.2% . . . . accuracy @ 10VA burden (73831) T3 | 1 | |
| 39 | 2511 | . . RESISTOR, wirewound, 1 ohm, ±10%, 300V (44655) R3 . | 1 | |
| | 6126P81/2 | c/w mounting bracket | | |
| 40 | | . . TERMINAL BOARD, 3-terminal, TB6 . . . . . | 1 | |
| 41 | MDA3501 | . . BRIDGE RECTIFIER, 35A, 100 PIV (09488) D3 . . . . . | 1 | |
| 42 | A13Z250 | . . FUSE, 250A, 130V (1P545) F1, F2 . . . . . | 2 | |
| 43 | 300U5 | . . DIODE, 300A, 50 PIV, 3/4" stud (59993) D1, D2 . . . | 2 | |

| FIG & INDEX NO. | PART NO. | DESCRIPTION . . . . | UNITS PER ASSY | AES OR NATO STOCK NUMBER |
|---|---|---|---|---|
| 6-16 44 | | . . TERMINAL BOARD, 42-terminal, 'Internal connections' (12277) TB2, consisting of: . . . . . | 1 | |
| | 1492-N1 | Mounting channel | 1 | |
| | 1492-CD8 | Single terminal block | 2 | |
| | 1492-N16 | End barrier for CD block | 1 | |
| | 1492-F8 | Single terminal Block | 40 | |
| | 1492-N18 | End barrier for style F block | 1 | |
| | 1492-N2 | Retaining clip | 2 | |
| 45 | V130LA208 | . . VARISTOR, 'GEMOV', 130V rms, 20 joule, (01816) RV1, RV2, RV3, RV4, RV5 . . . . . | 5 | |
| 46 | 27E121 | . . SOCKET, relay (12300) XK4 . . . . . | 1 | |
| -47 | 27E122 | . . SOCKET, octal (12300) XK3 . . . . . | 1 | |

- Denotes an item not illustrated or not shown as an assembled unit




TOP VIEW OF CABINET BASE



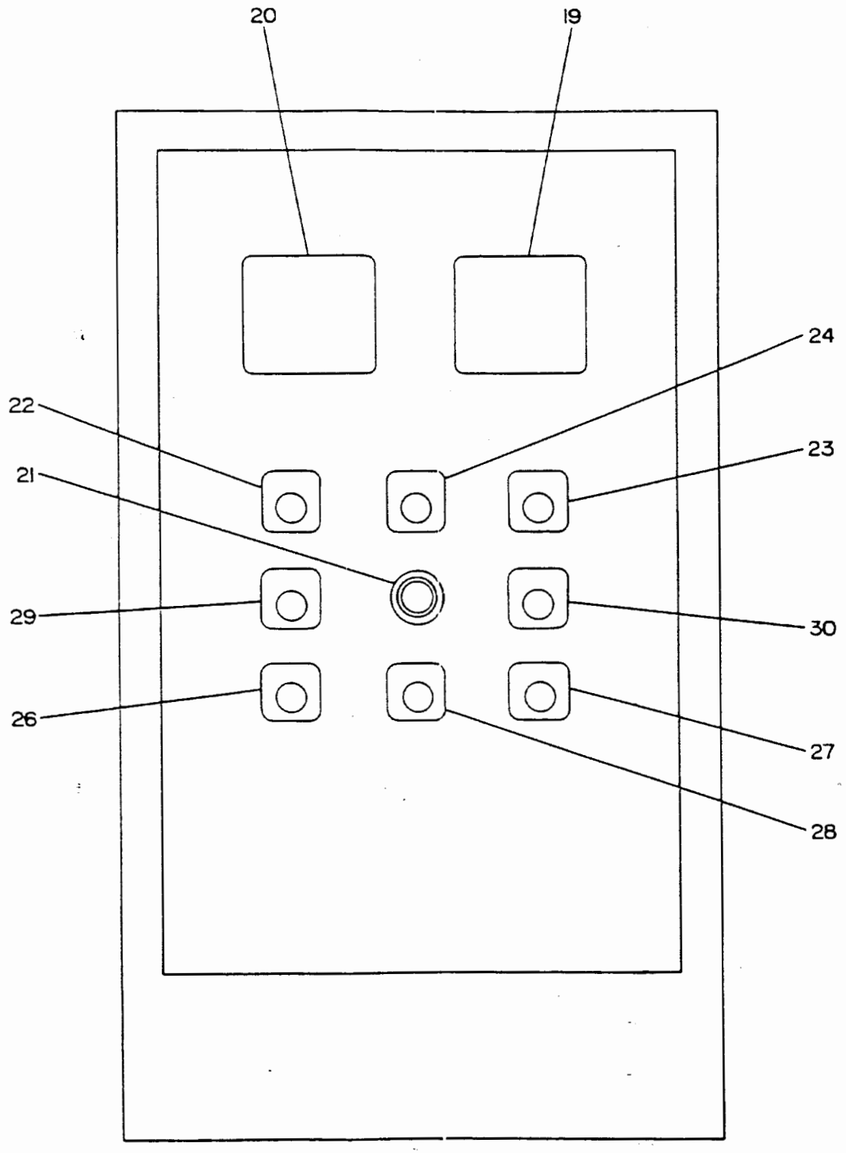




Figure 6-16 Electrical Cabinet

REGULATOR, ELECTROLYSER

| FIG & INDEX NO. | PART NO. | DESCRIPTION | UNITS PER ASSY | AES OR NATO STOCK NUMBER |
|---|---|---|---|---|
| 6-17 -1 | 102035 | . REGULATOR, Electrolyser (37282) | REF | |
| 2 | | . . COVER | 1 | |
| 3 | | . . SCREW, | 4 | |
| 4 | | . . NUT, Hex | 4 | |
| 5 | | . . BASE | 1 | |
| 6 | | . . CIRCUIT BOARD, | 1 | |

- Denotes an item not illustrated or not shown as an assembled unit

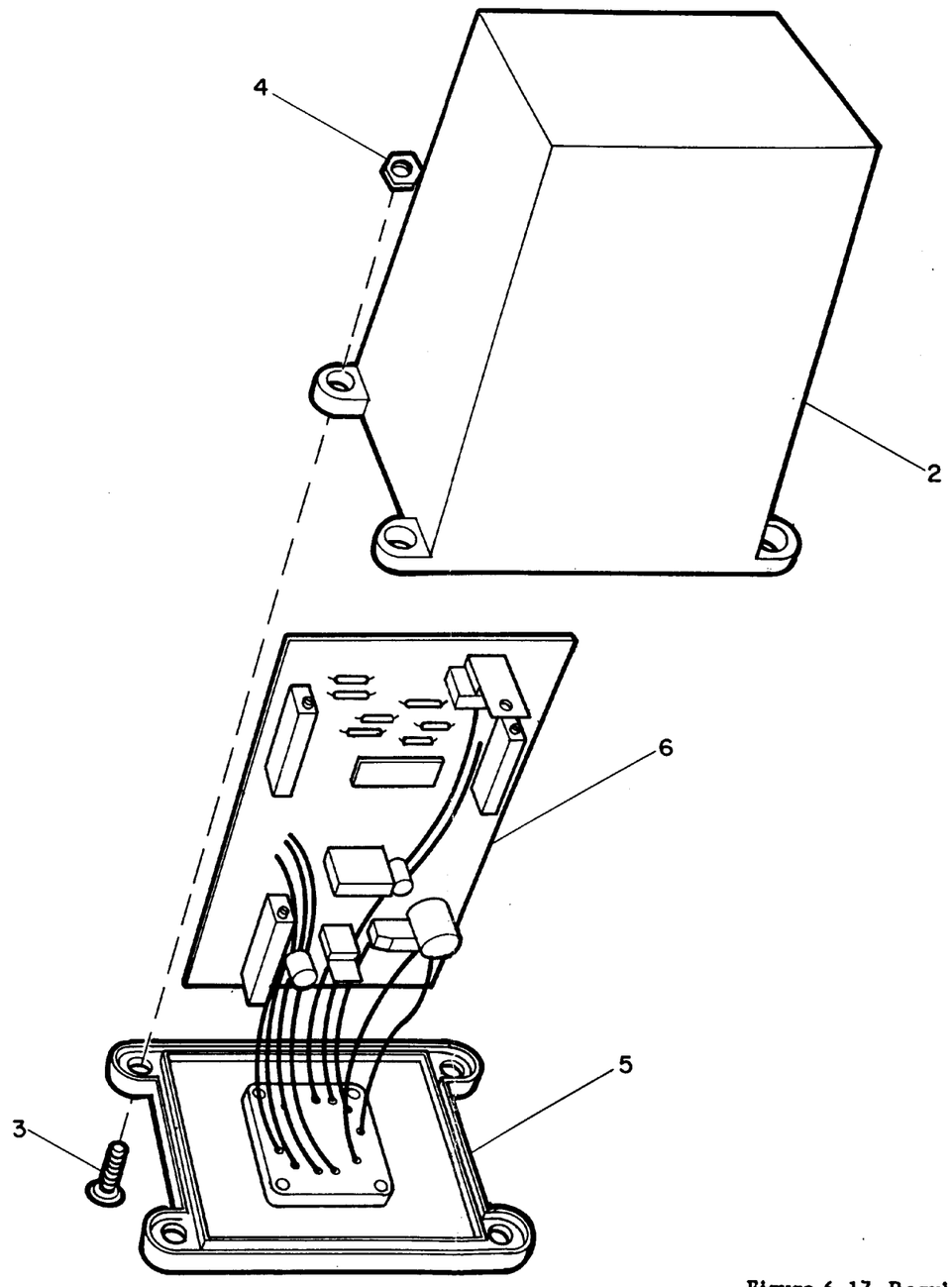



Figure 6-17 Regulator

WIND SWITCH ASSEMBLY

| FIG & INDEX NO. | PART NO. | DESCRIPTION . . . . | UNITS PER ASSY | AES OR NATO STOCK NUMBER |
|---|---|---|---|---|
| 6-18 -1 | AS408A1 | . SWITCH, Mercury, CLIP & SAIL Assembly, 'WIND' . . . . (09504) S8 | REF | |
| | 2MV1 | (Modified by Electrolyser (37282) | | |
| 2 | | . . SWITCH, Mercury & TERMINAL Assembly . . . . . | 1 | |
| | | ATTACHING PARTS | | |
| 3 | | . . SCREW . . . . . | 1 | |
| 4 | | . . NUT, Hex . . . . . | 1 | |
| | | ---*--- | | |
| 5 | | . . VANE & CLIP Assembly . . . . . | 1 | |
| | | ATTACHING PARTS | | |
| 6 | | . . BOLT . . . . . | 1 | |
| 7 | | . . WASHER . . . . . | 2 | |
| 8 | | . . NUT, Hex . . . . . | 2 | |
| | | ---*--- | | |
| 9 | | . . BRACKET . . . . . | 1 | |

- Denotes an item not illustrated or not shown as an assembled unit

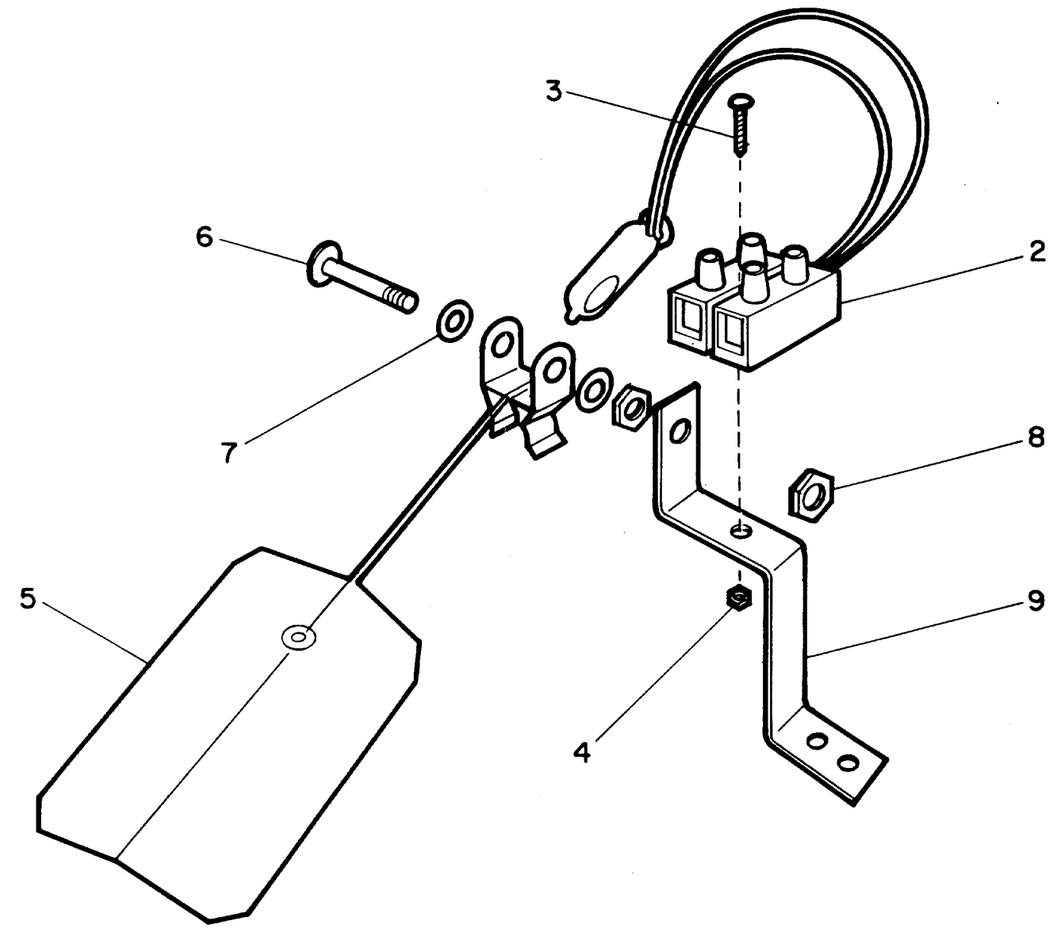



Figure 6-18 Wind Switch

BLOWER MOTOR ASSEMBLY

| FIG & INDEX NO. | PART NO. | DESCRIPTION . . . . | UNITS PER ASSY | AES OR NATO STOCK NUMBER |
|---|---|---|---|---|
| 6-19 -1 | E121272 115 | . MOTOR, Blower Assembly, 120v, 60 Hz, 1.3A, . . . . . 1290/1550 RPM (02324) B1 | REF | |
| 2 | | . . CAP, Ring . . . . . | 1 | |
| | | ATTACHING PARTS | | |
| 3 | | . . SCREW, . . . . . | 3 | |
| | | ---*--- | | |
| 4 | | . . CAGE . . . . . | 1 | |
| | | ATTACHING PARTS | | |
| 5 | | . . SCREW, . . . . . | 1 | |
| | | ---*--- | | |
| 6 | | . . SHROUD . . . . . | 1 | |
| 7 | | . . NUT, Hex . . . . . | 2 | |
| 8 | | . . MOTOR . . . . . | 1 | |
| 9 | | . . SCREW . . . . . | 1 | |

- Denotes an item not illustrated or not shown as an assembled unit

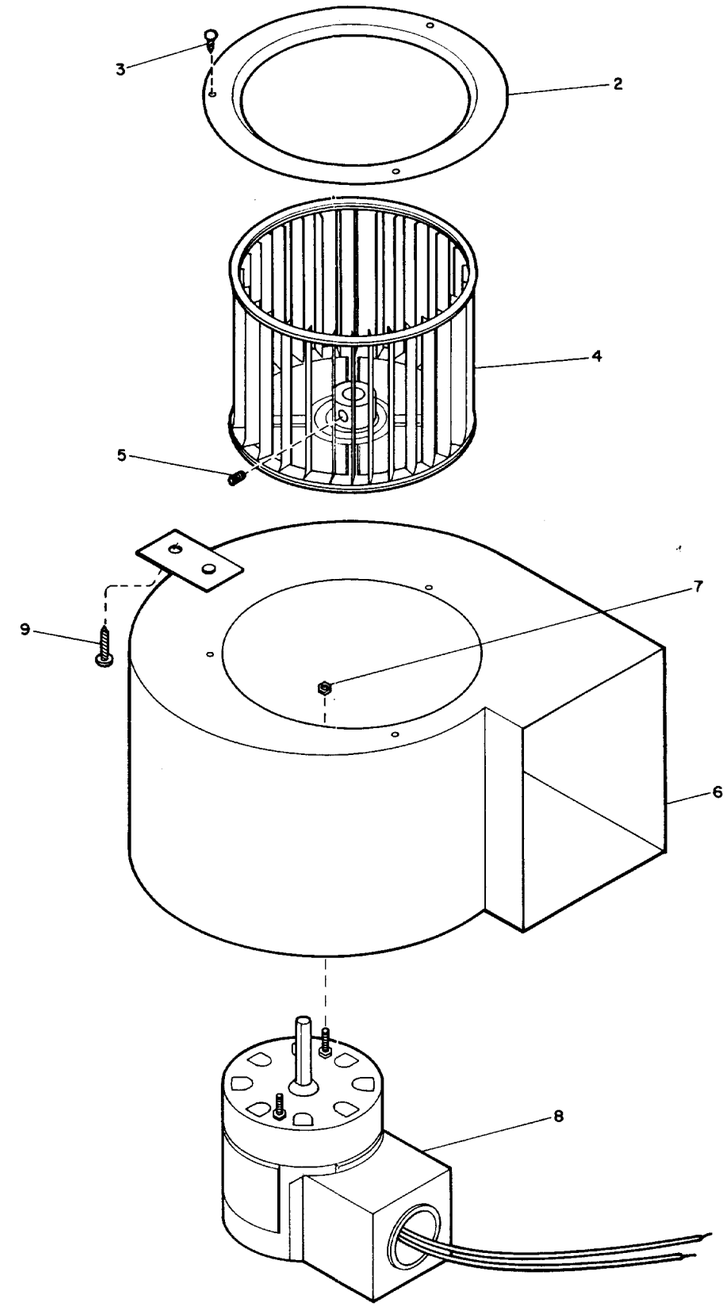



Figure 6-19 Blower Motor

ROOM TEMPERATURE SWITCH AND SENSOR ASSEMBLY

| FIG & INDEX NO. | PART NO. | DESCRIPTION . . . . | UNITS PER ASSY | AES OR NATO STOCK NUMBER |
|---|---|---|---|---|
| 6-20 -1 | | . SWITCH & SENSOR Assembly, (including wall passthru . . hardware) | REF | |
| -2 | A19ABC-24 | . . SWITCH & SENSOR Unit, 'ROOM COLD', SPDT, 120V, . . . 16A, -30° to 100°F, Thermostat, set at 40°F, 1-FORM C contact, (31626) S7 | 1 | |
| | FTG13A-600 | c/w packing nut | | |
| 3 | | . . . SWITCH . . . . . | 1 | |
| 4 | | . . . SENSOR . . . . . | 1 | |
| 5 | | . . HARDWARE WALL PASSTHRU Assembly . . . . . | 1 | |

- Denotes an item not illustrated or not shown as an assembled unit

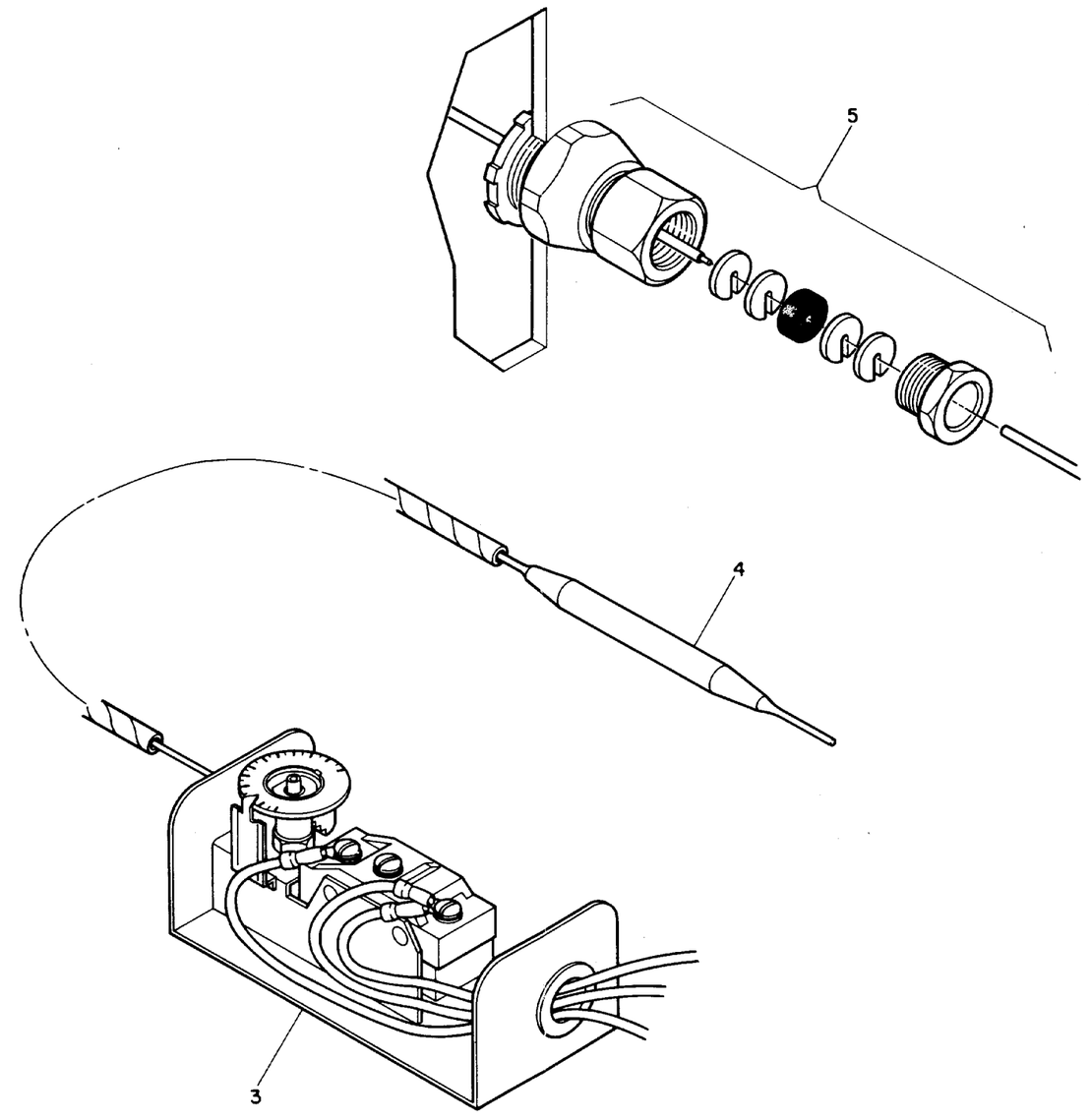



Figure 6-20 Room Temperature Switch and Sensor (including wall passthru hardware)

# GAS DETECTOR SYSTEM

| FIG & INDEX NO. | PART NO. | DESCRIPTION . . . . | UNITS PER ASSY | AES OR NATO STOCK NUMBER |
|---|---|---|---|---|
| 6-21 -1 | 23-7179 | . GAS DETECTION SYSTEM, CD800W (05083) . . . . . | REF | |
| 2 | 23-4043 | . . CIRCUIT BOARD ASSEMBLY, CD800/830 (05083) | | |
| | | ATTACHING PARTS | | |
| 3 | 0004-5191 | . . RELAY, Standard (05083) K1, K2, K3 . . . . . | 3 | 0026-5187 |
| 4 | 0104-7702 | . . SPRING, Relay Hold-down (05083) . . . . . | 3 | |
| 5 | 23-4052 | . . METER, 1 mA, 0-100% L.E.L. Scale, DW91, (01816) . . . . . | 1 | |
| 6 | 382 | . . LAMP 14V, T1 ( ) . . . . . | 4 | 0026-5186 |
| 7 | 355-052-00 | . . SWITCH, Pushbutton, Reset ( ) . . . . . | 1 | |

`enotes an item not illustrated or not shown as an assembled unit

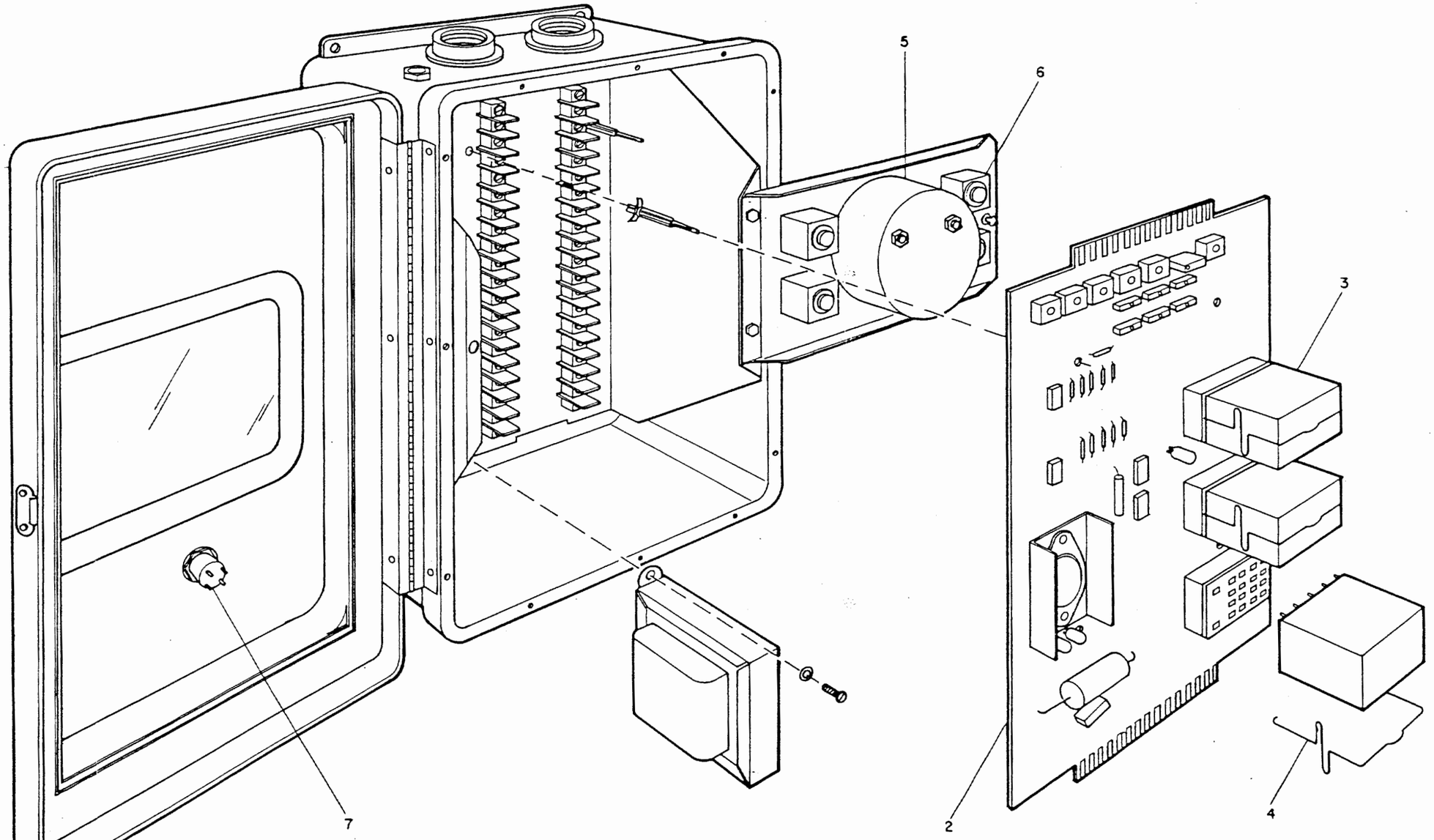



**Figure 6-21** CD800W Gas Detector System Circuit Board Assembly

CONTROL/ALARM UNIT

| FIG & INDEX NO. | PART NO. | DESCRIPTION . . . . | UNITS PER ASSY | AES OR NATO STOCK NUMBER |
|---|---|---|---|---|
| 6-22 -1 | D0614-S21 | . CONTROL/ALARM UNIT (36401) . . . . . | REF | |
| 2 | | . . TERMINAL BOARD, 10-terminal, Style F . . . . . (12277) TB1, consisting of: | 1 | |
| | 1492-N1 | Mounting channel | 1 | |
| | 1492-F8 | Single terminal Block | 10 | |
| | 1492-N18 | End barrier | 1 | |
| | 1492-N2 | End anchor | 2 | |
| 3 | | . . TERMINAL BOARD, 2-terminal, Style F . . . . . (12277) TB2, consisting of: | 1 | |
| | 1492-N1 | Mounting channel | 1 | |
| | 1492-F8 | Single terminal Block | 2 | |
| | 1492-N18 | End barrier | 1 | |
| | 1492-N2 | End anchor | 2 | |
| 4 | | . . TERMINAL BOARD, 4-terminal, Style F . . . . . (12277) TB3, TB4 consisting of: | 2 | |
| | 1492-N1 | Mounting channel | 1 | |
| | 1492-F8 | Single terminal Block | 4 | |
| | 1492-N18 | End barrier | 1 | |
| | 1492-N2 | End anchor | 2 | |
| 5 | 702-C0D92 | . . RELAY, Contactor (12277) K1 . . . . . (See also figure 6-24) | 1 | |
| 6 | V180ZA10 | . . VARISTER (01816) RV1, RV2 . . . . . | 2 | |
| 7 | KUP14A15 | . . RELAY, 120Vac, 3PDT, 10 Amp contacts (12300) K2 . . | 1 | |
| 8 | 27E121 | . . SOCKET, Relay (12300) XK2 . . . . . | 1 | |
| -9 | D0613-R137 | . . BOX, Panel, Hammond No 1414PHM6 (or S80079), . . . . modified by AES (36401) | 1 | |
| | | . . (For Front Panel parts see figure 6-23) | | |
| 10 | C0613-R138 | . . INNER PANEL (36401) . . . . . | 1 | |

- Denotes an item not illustrated or not shown as an assembled unit

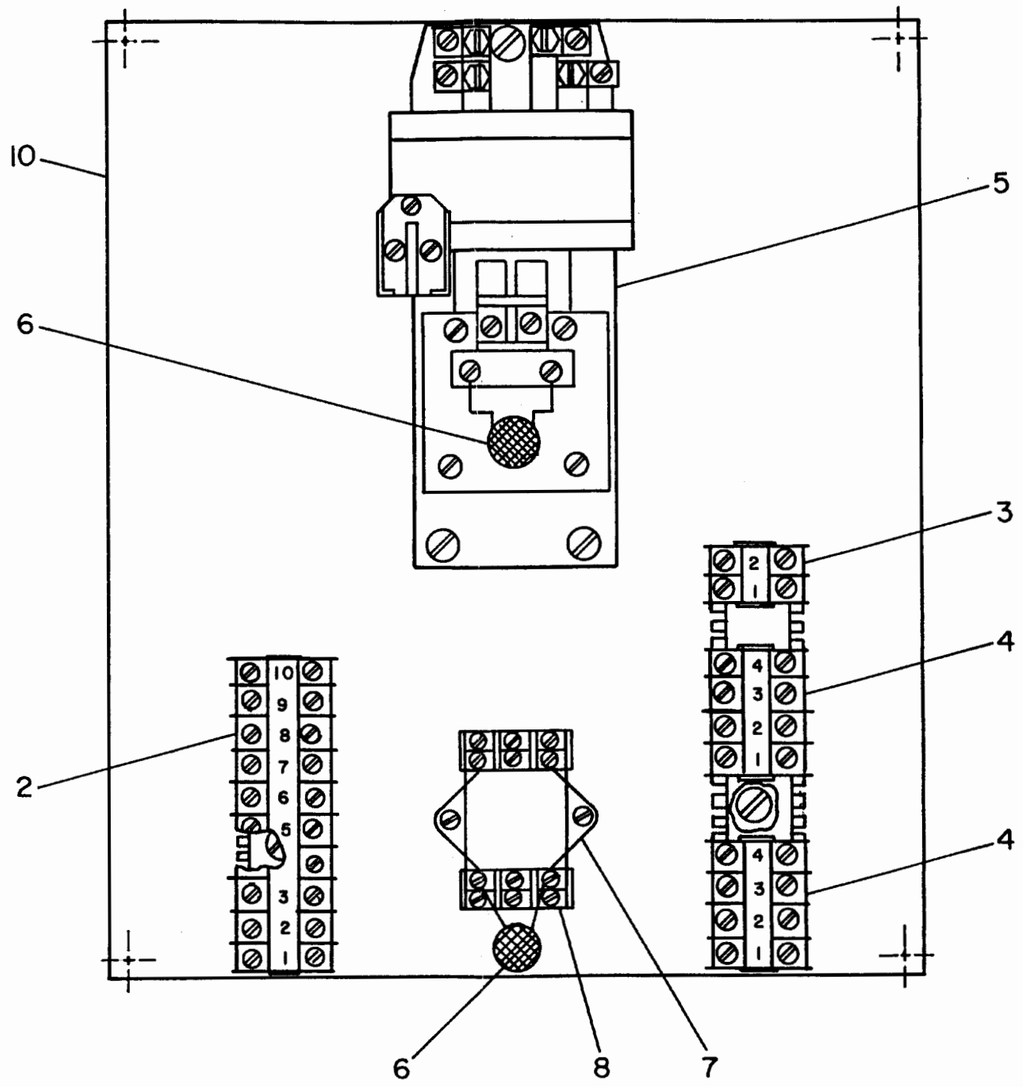



Figure 6-22 Control/Alarm Unit

PANEL COVER, CONTROL/ALARM UNIT

| FIG & INDEX NO. | PART NO. | DESCRIPTION . . . . | UNITS PER ASSY | AES OR NATO STOCK NUMBER |
|---|---|---|---|---|
| 6-23 -1 | | . PANEL COVER, Control/Alarm Unit (36401) . . . . . | REF | |
| 2 | 103-3101-1212-403 | . . HOLDER, Lamp, 75W, 125V, Green dome lens, Frosted (72619) XDS1 . . . . . | 1 | |
| 3 | 103-3101-1211-403 | . . HOLDER, Lamp, 75W, 125V, Red dome lens, Frosted (72619) XDS2 . . . . . | 1 | |
| -4 | 6S6-145V | . . LAMP, 6W, 145V (09819) DS1, DS2 . . . . . | 2 | 6240-2600 |
| 5 | HKL-X-20A1 | . . HOLDER, Fuse (71400) XF1, XF2, XF3 . . . . . | 3 | |
| -6 | MDL-1 | . . FUSE, 1A Slo Blo (71400) F1, F2, F3 . . . . . | 3 | 5920-0530 |
| 7 | 800T-H2A4 | . . SWITCH, 2-NC, Maintained, Black with white insert (12277) S1 . . . . . | 1 | |
| 8 | 800T-A1A | . . SWITCH, Pushbutton, Green flush head, 1-NC, 1-NO (12277) S2 . . | 1 | |
| 9 | 800T-B6D1 | . . SWITCH, Pushbutton, Red extended head, 1-NO (12277) S3 . . . . | 1 | |

- Denotes an item not illustrated or not shown as an assembled unit

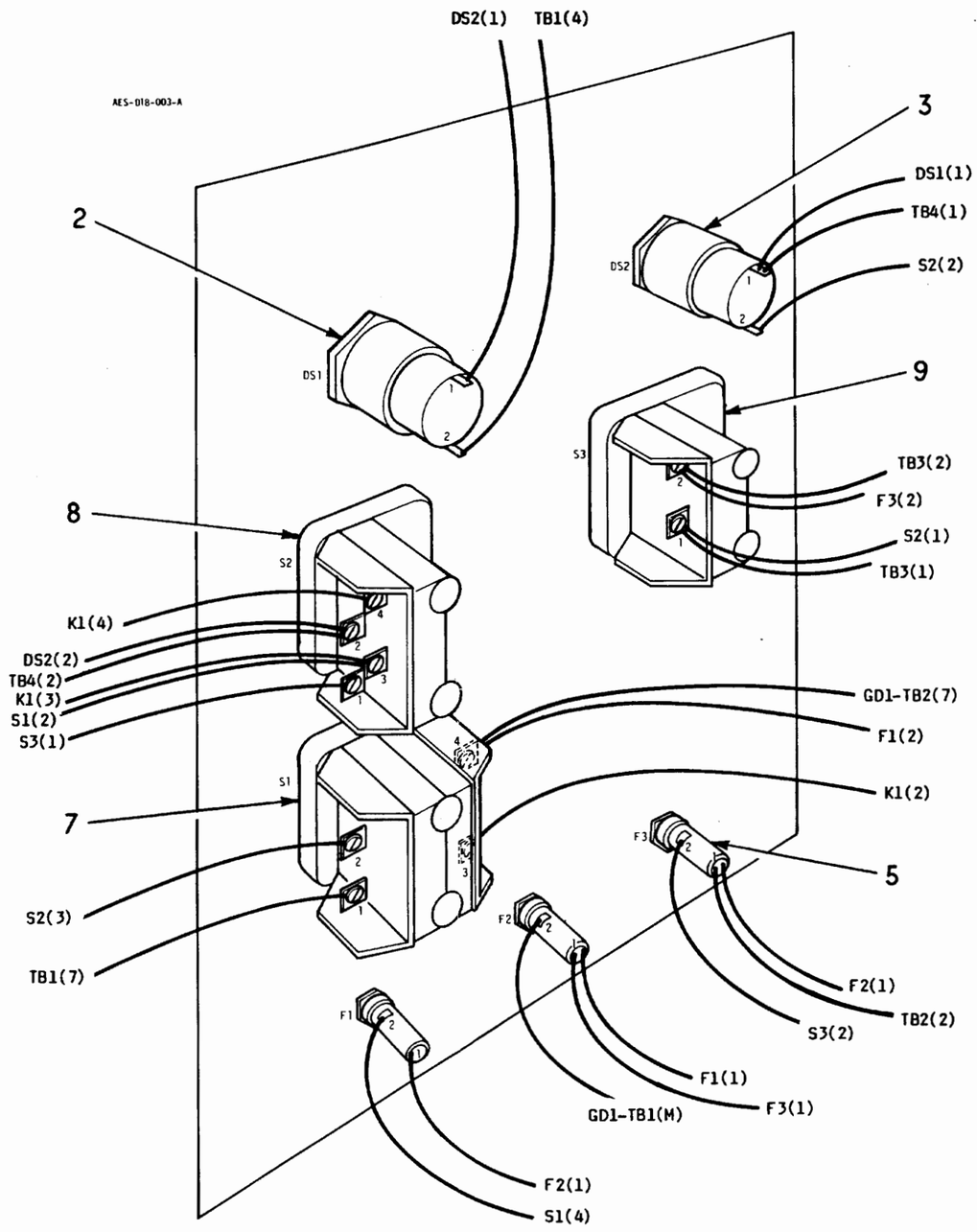



Figure 6-23 Panel Cover, Control/Alarm Unit

CONTROL/ALARM UNIT K1 CONTACTOR

| FIG & INDEX NO. | PART NO. | DESCRIPTION | UNITS PER ASSY | AES OR NATO STOCK NUMBER |
|---|---|---|---|---|
| | | . . . . | | |
| 6-24 -1 | 702-C0D92 | . CONTACTOR, Relay, 120Vac, 2-pole, 1 N.O. . . . . | REF | |
| | | Hold-in contact (12277) K1 | | |
| | 1495-G1 | c/w auxiliary contact, 1 N.C. | | |
| 2 | V18OZA10 | . VARISTOR (01816) RV1 . . . . . | 1 | |

- Denotes an item not illustrated or not shown as an assembled unit

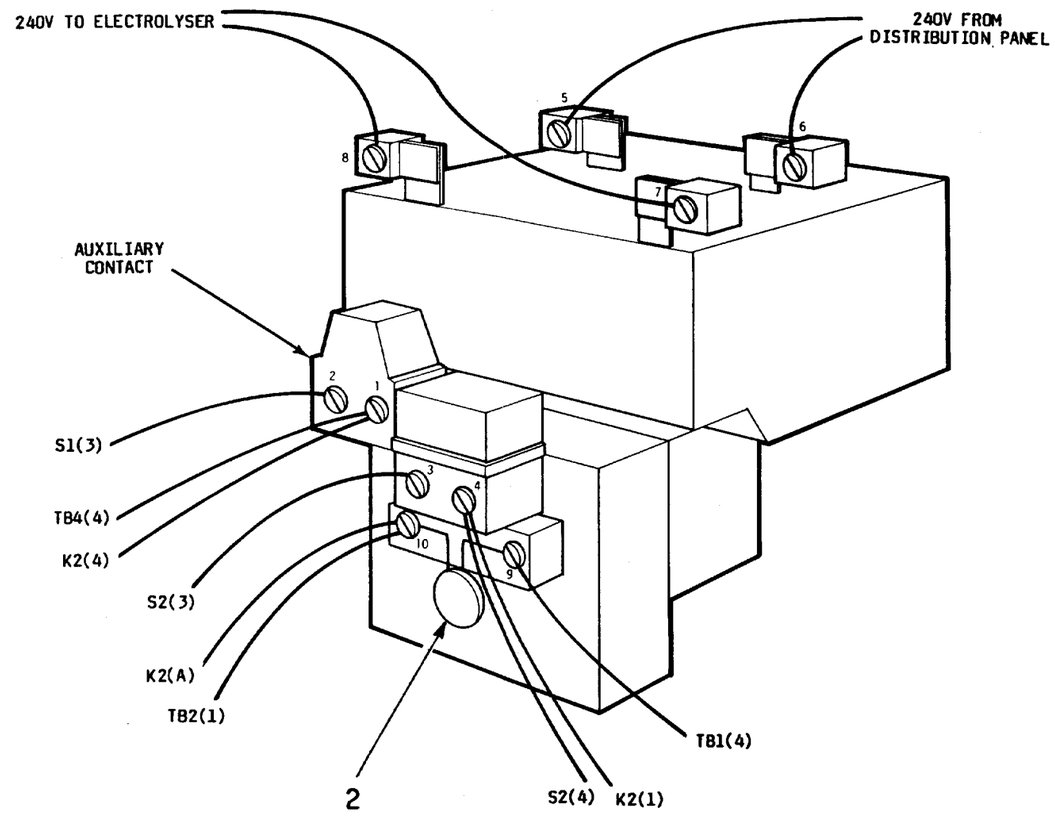



Figure 6-24 Control/Alarm Unit K1 Contactor

WALL VENT HEATER

| FIG & INDEX NO. | PART NO. | DESCRIPTION | UNITS PER ASSY | AES OR NATO STOCK NUMBER |
|---|---|---|---|---|
| 6-25 -1 | C0614-S27 | . HEATER, Wall Vent (37282) | REF | |
| 2 | 30-E1-60-E | . . GAUGE, Temperature, (38056) | 1 | |
| 3 | | . . REDUCER TEE | 1 | |
| 4 | | . . CONNECTOR, Male, Swagelok | 1 | |
| 5 | | . . NUT, Hex | 1 | |
| 6 | | . . PIPE/FLANGE ASSEMBLY | 1 | |
| | | ATTACHING PARTS | | |
| 7 | | . . SCREW, 1/4"-20 x 3/4", Hex Head Cap | 6 | |
| | | ---*--- | | |
| 8 | | . . . BLANKET, Asbestos | 1 | |
| 9 | | . . . CLAMP, Hose | 4 | |
| 10 | OT-1025 | . . . HEATER, Strip, Element type , 259W, 240V (36137) | 1 | |
| 11 | 30,000.0 | . . . THERMOSTAT, (36137) TH1, TH2 | 2 | |
| 12 | | . . . WIRE, High Temperature, 14 AWG, Type SEW | AR | |
| 13 | A-30 | . . HEATER, Ring, 450W, 240V (36137) | 1 | |
| 14 | | . . CONDUIT UNION, 1/2", Explosion Proof | 1 | |
| 15 | | . . CONDUIT SEAL, 1/2" | 1 | |
| 16 | | . . HOUSING | 1 | |

- Denotes an item not illustrated or not shown as an assembled unit

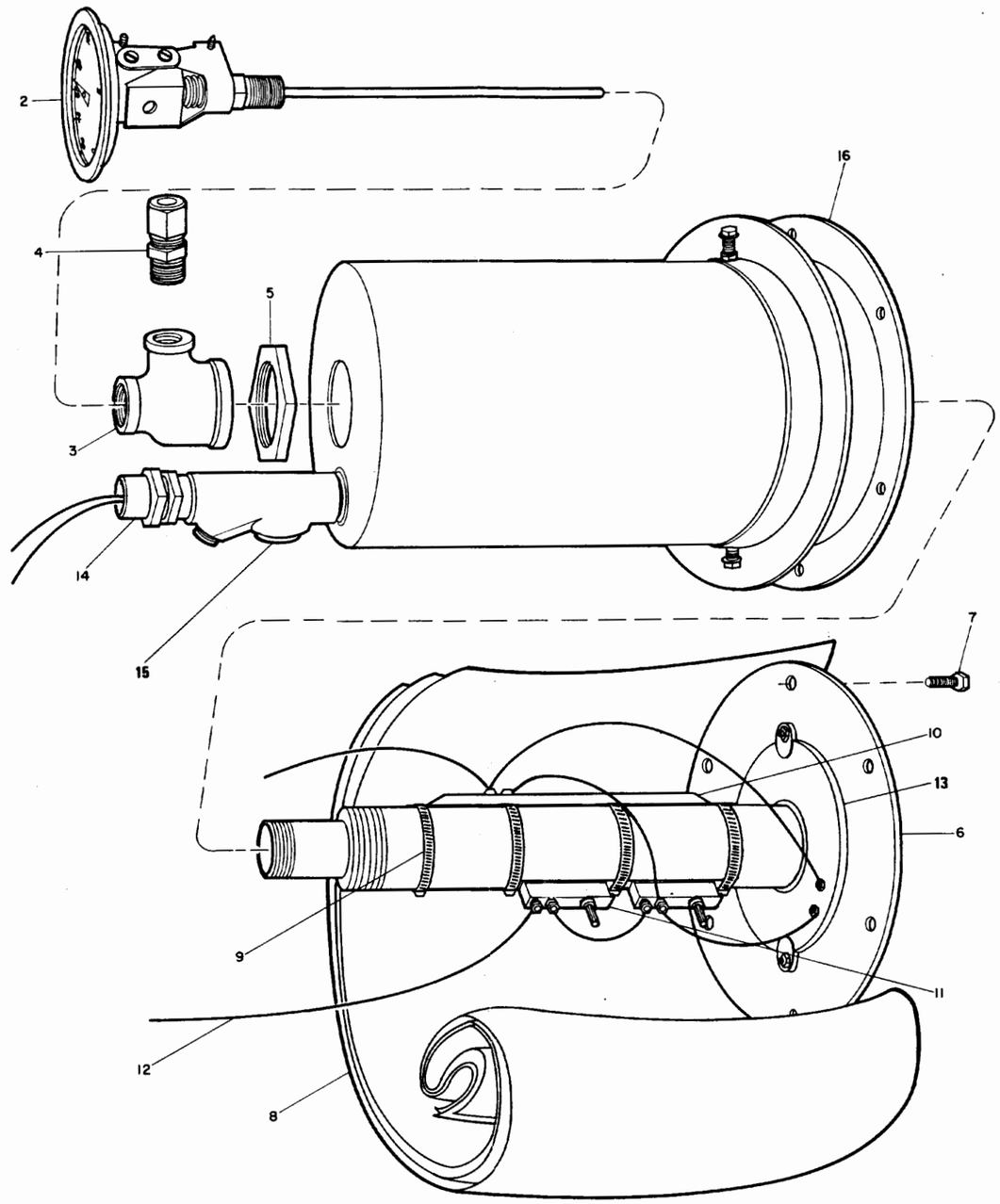



Figure 6-25 Wall Vent Heater

GAS FYRITE TESTER

| FIG & INDEX NO. | PART NO. | DESCRIPTION | UNITS PER ASSY | AES OR NATO STOCK NUMBER |
|---|---|---|---|---|
| 6-26 -1 | | . TESTER, Gas, Fyrite (05083) | REF | 0026-2935 |
| 2 | 11-0019 | . . PLUNGER, Valve (05083) | 1 | |
| 3 | 11-0026 | . . SPRING, Plunger Valve (05083) | 1 | 0026-4580 |
| 4 | 11-0136 | . . CAP, Ring, Top with Gasket (05083) | 1 | |
| | | ATTACHING PARTS | | |
| 5 | 01-0661 | . . SCREW, Oval Head (05083) | 4 | |
| | | ---*--- | | |
| 6 | 11-0132 | . . CAP, Top (05083) | 1 | |
| 7 | 11-0143 | . . GASKET, Top (05083) | 1 | |
| 8 | 11-0020 | . . GASKET, Plunger Valve (05083) | 1 | |
| 9 | 11-0102 | . . BEZEL (05083) | 4 | |
| | | ATTACHING PARTS | | |
| 10 | 11-0110 | . . SCREW, Bezel (05083) | 8 | |
| | | ---*--- | | |
| 11 | 11-0126 | . . CAP, Bottom (05083) | 1 | |
| | | ATTACHING PARTS | | |
| 12 | 01-0661 | . . SCREW, Oval Head (05083) | 4 | |
| | | ---*--- | | |
| 13 | 11-0021 | . . DIAPHRAGM (05083) | 1 | |
| 14 | 11-0144 | . . SCALE (05083) | 1 | |
| | | ATTACHING PARTS | | |
| 15 | 11-0105 | . . SCREW, Scale (05083) | 1 | |
| 16 | 02-3690 | . . NUT, Scale Screw (05083) | 1 | |
| | | ---*--- | | |
| 17 | 11-0109 | . . GASKET, Bezel (05083) | 2 | 0026-4581 |
| 18 | 11-0140 | . . BODY, Fyrite (05083) | 1 | |
| -19 | 11-0169 | . . REFILL, Fluid (05083) | | 0026-4095 |
| -20 | 11-7054 | . . KIT, REPAIR (consists of item No's 3, 17, 19) (05083) | REF | 0026-2936 |
| -21 | 11-7029 | . . ASSEMBLY (05083) Sampling consists of following items | 1 | |
| -22 | 11-0120 | . . . BULB, Aspirator for sampling assembly (05083) | 1 | 0026-4074 |
| -23 | 11-0106 | . . . TUBE, Sampling (05083) | 1 | |
| -24 | 11-0118 | . . . TUBING, Rubber, 6" Long (05083) | 1 | |
| -25 | 11-0122 | . . . PACKING, for Filter Tube (05083) | 1 | |
| -26 | 11-0130 | . . . TUBE, Filter (05083) | 1 | |
| -27 | 11-0180 | . . . FILTER, Nipple for end of tube (05083) | 2 | |
| -28 | 11-0119 | . . . TUBING, Rubber, 3 ft. long (05083) | 1 | |
| -29 | 11-0138 | . . . VALVE, Inlet, Red (05083) (05083) | 1 | |
| -30 | 11-0127 | . . . VALVE, Outlet, Green (05083) | 1 | |
| -31 | 11-0152 | . . . TIP, Connector with Tube (05083) | 1 | |

- Denotes an item not illustrated or not shown as an assembled unit

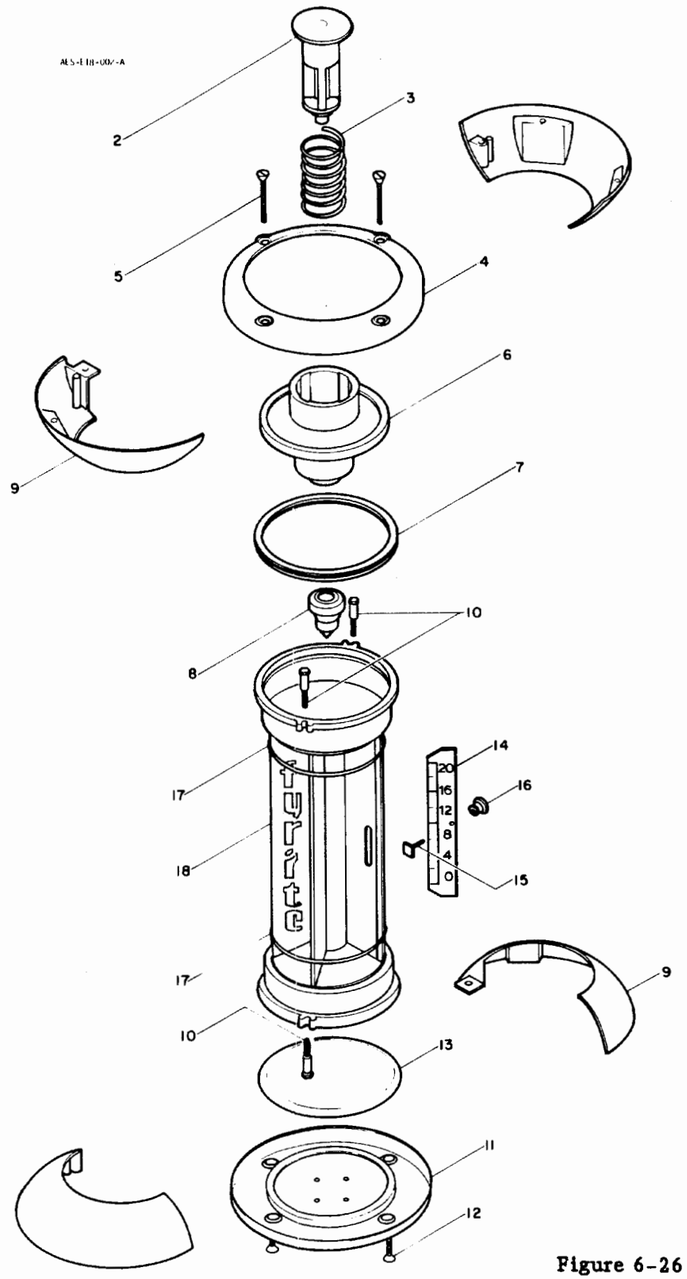



Figure 6-26 Fyrite Tester

GAS SENSOR AND EXTENDER SOCKET ASSEMBLY

| FIG & INDEX NO. | PART NO. | DESCRIPTION | UNITS PER ASSY | AES OR NATO STOCK NUMBER |
|---|---|---|---|---|
| 6-27 -1 | 0023-4012 | . GAS SENSOR AND EXTENDER SOCKET ASSEMBLY CD800W (05083) | REF | |
| 2 | 0023-4019 | . . BODY, Detector (05083) | 1 | |
| 3 | 0023-4027 | . . ADAPTER, Test Socket (05083) | 1 | |
| 4 | 800-080-40 | . . SENSOR (05083) | 1 | 0026-5184 |
| 5 | 0005-5007 | . . O-RING (05083) | 1 | |
| 6 | | . . SET SCREW, 6-32 | 1 | |
| 7 | 0023-4692 | . . SHIELD ASSEMBLY (05083) | 1 | |

- Denotes an item not illustrated or not shown as an assembled unit

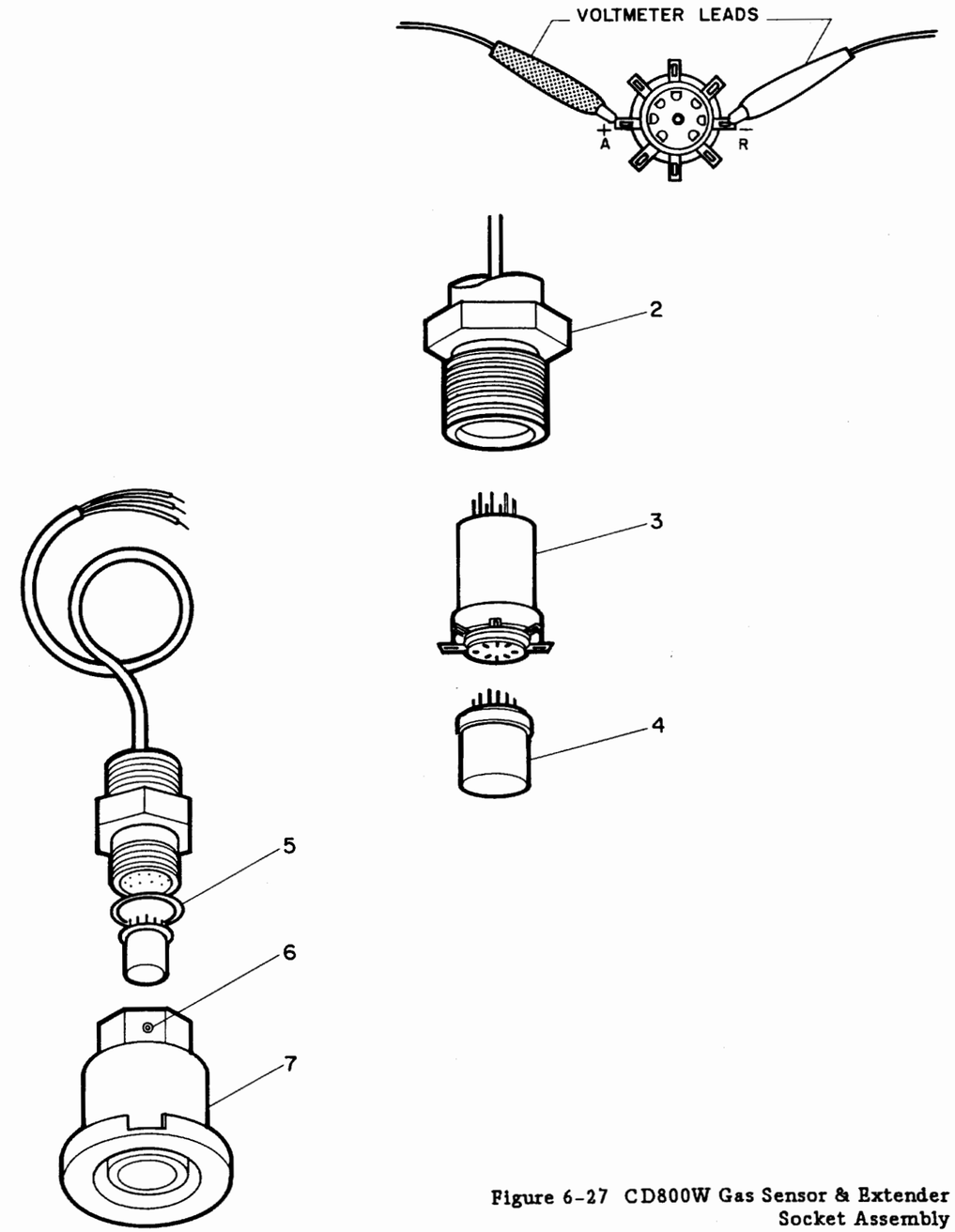



Figure 6-27 CD800W Gas Sensor & Extender Socket Assembly

GAS CALIBRATION KIT

| FIG & INDEX NO. | PART NO. | DESCRIPTION . . . . | UNITS PER ASSY | AES OR NATO STOCK NUMBER |
|---|---|---|---|---|
| 6-28 -1 | 0023-7260 | . GAS CALIBRATION KIT (05083) . . . . . | REF | |
| 2 | 0023-4692 | . . ASSEMBLY, Shield (05083) . . . . . | 1 | |
| 3 | 0023-4098 | . . CUP, Sample (05083) . . . . . | 1 | |
| 4 | 17-0027 | . . HOSE, Rubber (05083) . . . . . | 1 | |
| 5 | 24-0191 | . . REGULATOR (05083) . . . . . | 1 | |
| 6 | 0023-1487 | . . VALVE, Dispensing (05083) . . . . . | 1 | |
| 7 | 0023-4005 | . . CYLINDER, Gas (05083) . . . . . | 1 | 0026-5185 |
| 8 | 0023-1475 | . . CASE, Carrying (05083) . . . . . | 1 | |

- Denotes an item not illustrated or not shown as an assembled unit

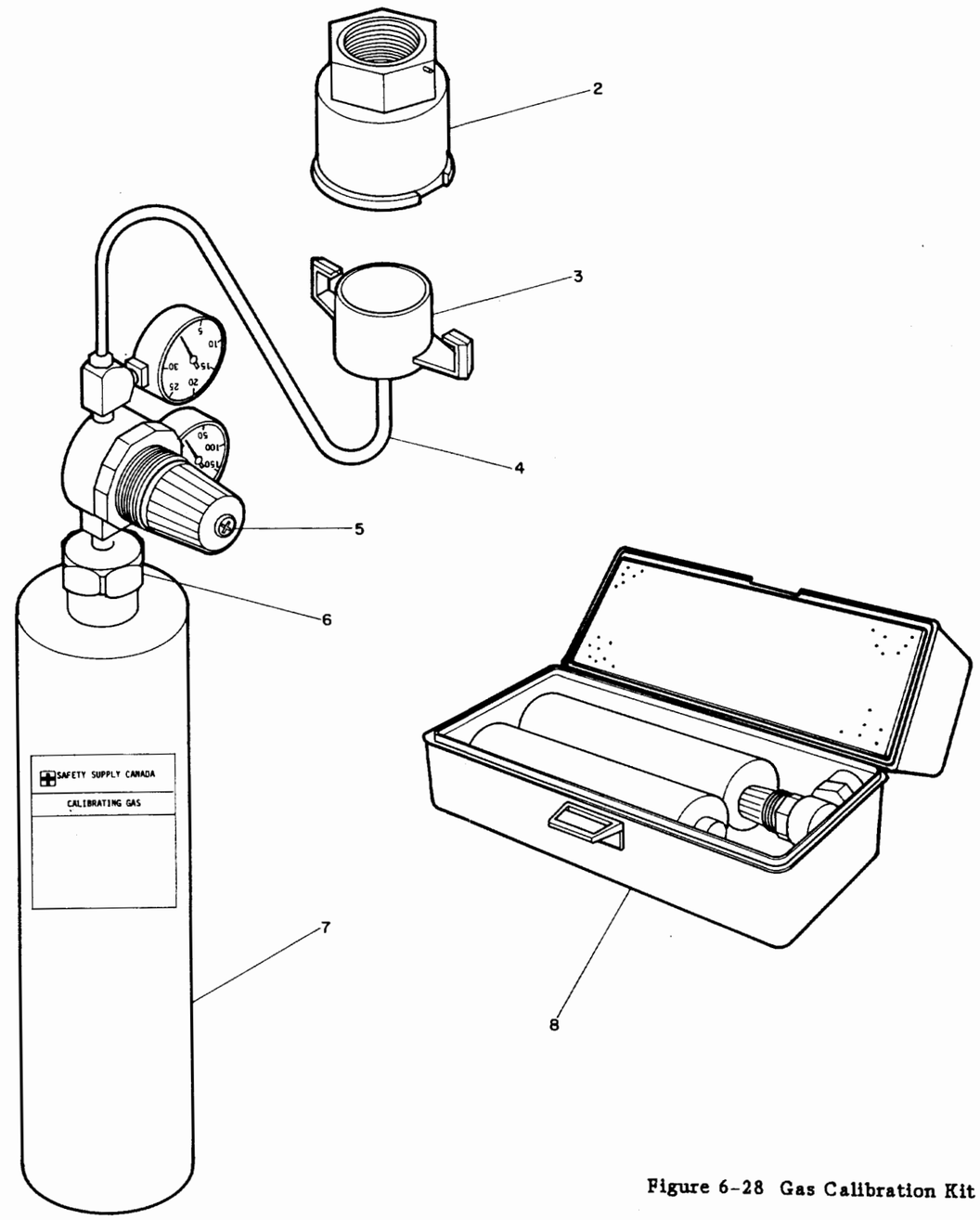



Figure 6-28 Gas Calibration Kit

# ELECTROLYTIC HYDROGEN GENERATOR

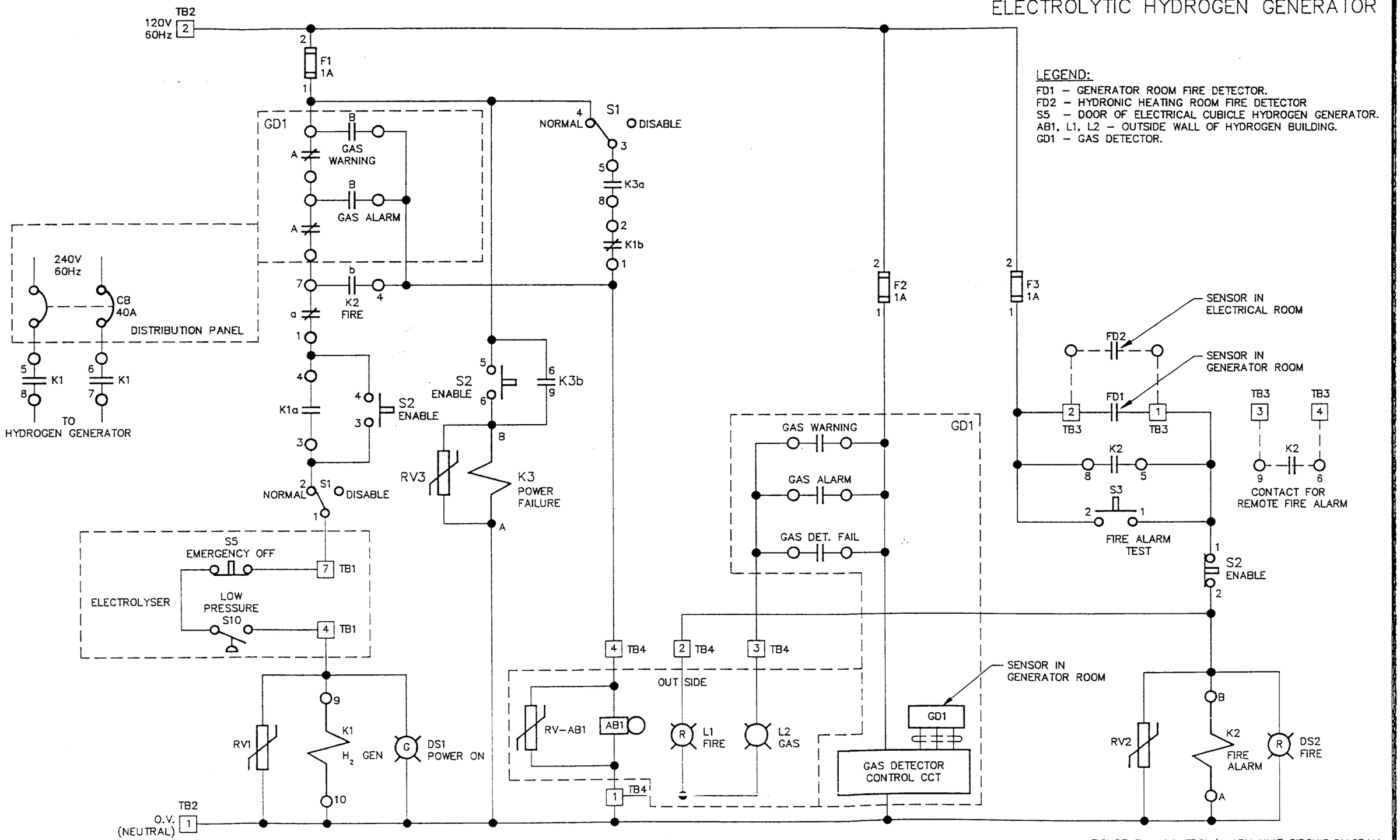
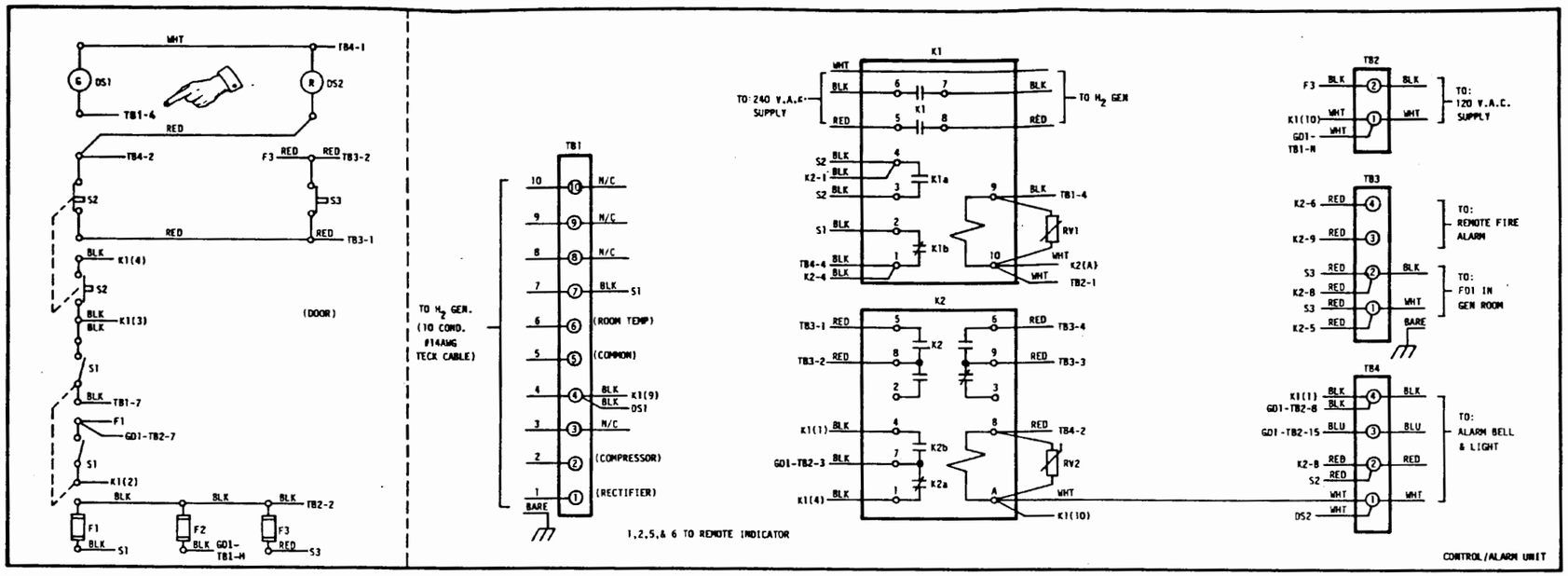



FIGURE 7-1 CONTROL/ALARM UNIT CIRCUIT DIAGRAM



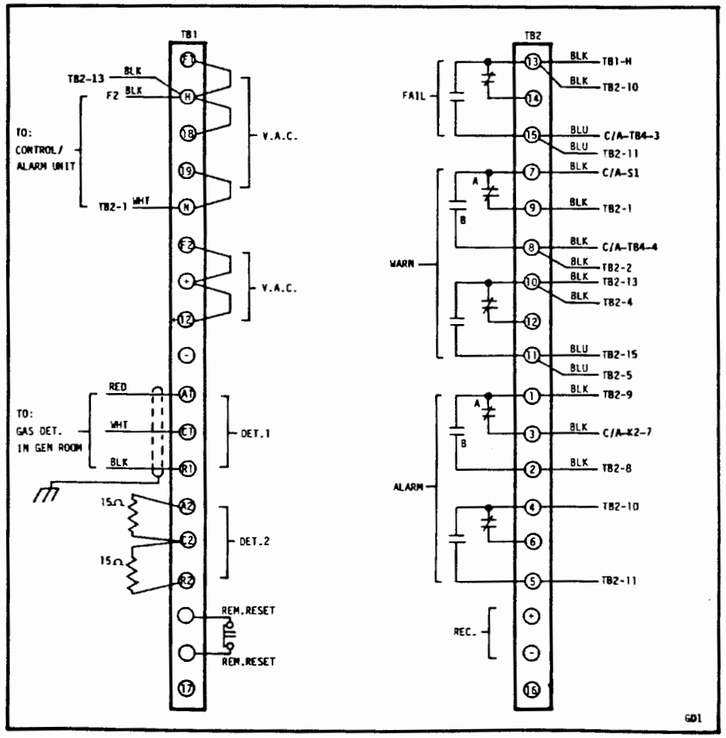




Figure 7-2 Wiring Diagram, Control/Alarm Unit

VALVE LIST

| ITEM | DESCRIPTION |
|---|---|
| V-1 | Three Way Valve Direct Hydrogen To Gasholder or Vent |
| V-2 | Compressor Crankcase Drain |
| V-3 | Compressor Inlet |
| V-4 | Unloader Condensate Drain |
| V-5 | Gasholder Water Tank Drain |
| V-6 | Differential Pressure Switch Reset |
| V-7 | Hydrogen To Storage Tank |
| V-8 | Storage Tank |
| V-9 | Hydrogen To Balloon Filling |
| V-10 | Feed Water Tank Drain |
| V-11 | Feed Water Makeup To Cell |
| V-12 | Condensate Drainage From Storage Tank |
| V-13 | Condensate Drainage From Storage Tank |
| V-14 | Storage Tank Purge |
| V-15 | Hydrogen Sampling |
| V-16 | Raw Water Shut-Off |
| V-17 | Gasholder Vent |

EQUIPMENT LIST

| ITEM | DESCRIPTION |
|---|---|
| 1 | Rectifier |
| 2 | 250 Ampere Cell |
| 3 | Water Seal |
| 4 | Gasholder |
| 5 | Compressor & Motor |
| 6 | Aftercooler |
| 7 | Check Valve, Nupro |
| 8 | High Pressure Cut-Off Switch S12 |
| 9 | Safety Relief Valve (Set At 125 P.S.I. G) |
| 10 | Low Pressure Cut-Off Switch S10 |
| 11 | Gasholder High Level Switch-Sounds Alarm S17 |
| 12 | Gasholder High Level Switch-Starts Compressor S13 |
| 13 | Inlet Valve Micro Switch S16 |
| 14 | Feed Water Storage Tank |
| 15 | Hydrogen Storage Tank |
| 16 | Safety Relief Valve |
| 17 | Pressure Gauge - P.D.S. |
| 18 | Pressure Gauge - High Pressure Line |
| 19 | Vent Pipe Wall Adapter |
| 20 | Purge Air Wall Adapter And Duct Work |
| 21 | Pulsation Dampener |
| 22 | Gas Purity Tester |
| 23 | Filter-Separator-Balston |
| 24 | Pressure Gauge - Balston Filter Line |
| 25 | Check Valve PDS, Nupro |
| 26 | Differential Pressure Switch S11 |
| 27 | Flow Rate Indicator - Demineralizer |
| 28 | Demineralizer Cartridge |
| 29 | Manometer |
| 30 | Pressure Gauge - Storage Tank |
| 31 | Compressor - Unloading Solenoid Valve L2 |
| 32 | Gasholder Low Level Switch - Stops Compressor and Opens Unloading Solenoid Valve - S14 |
| 33 | Gasholder Low Level Switch - S15 - Stops Rectifier |
| 34 | Check Valve, Nupro |

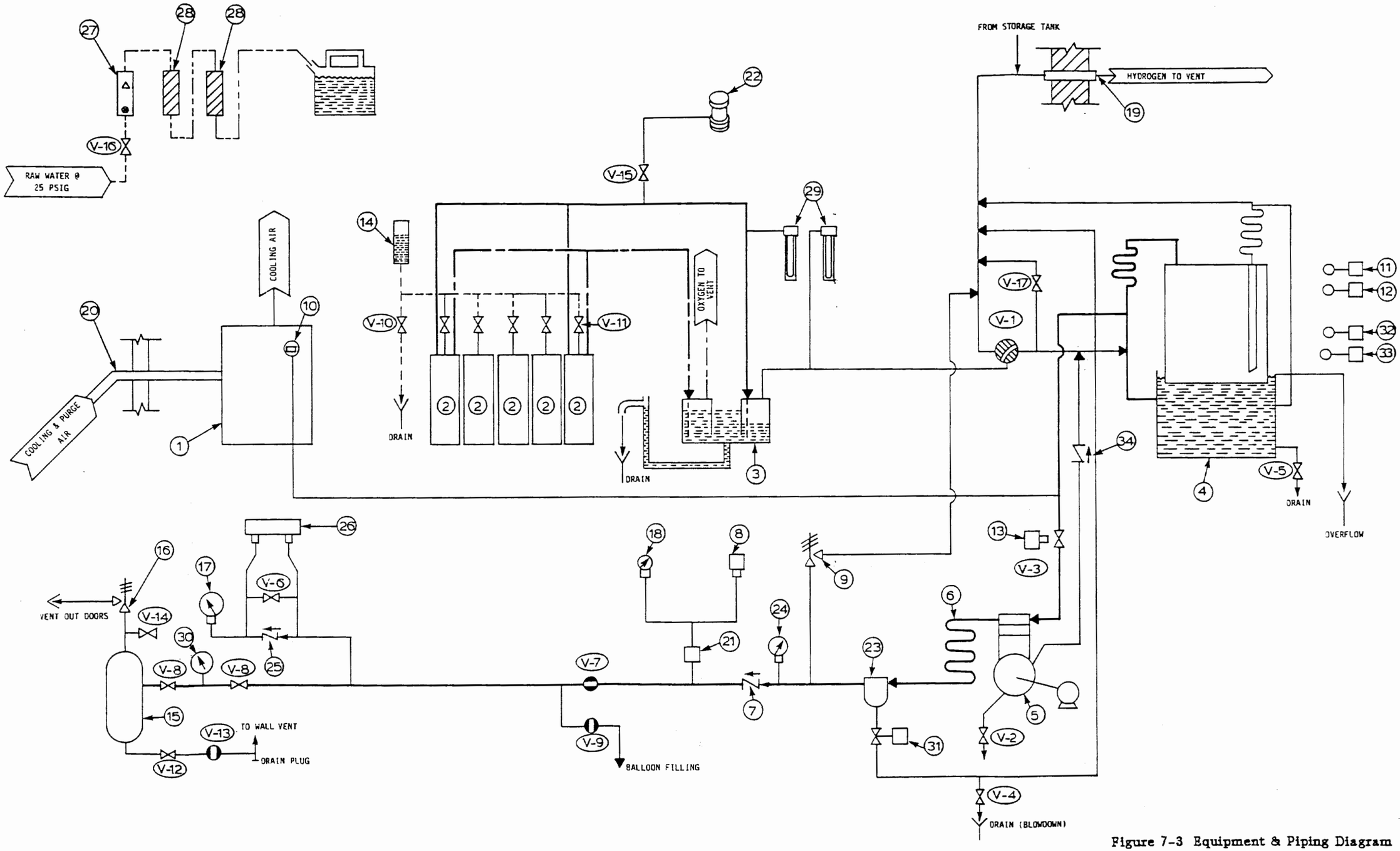



Figure 7-3 Equipment & Piping Diagram
Electrolyser M20-AES

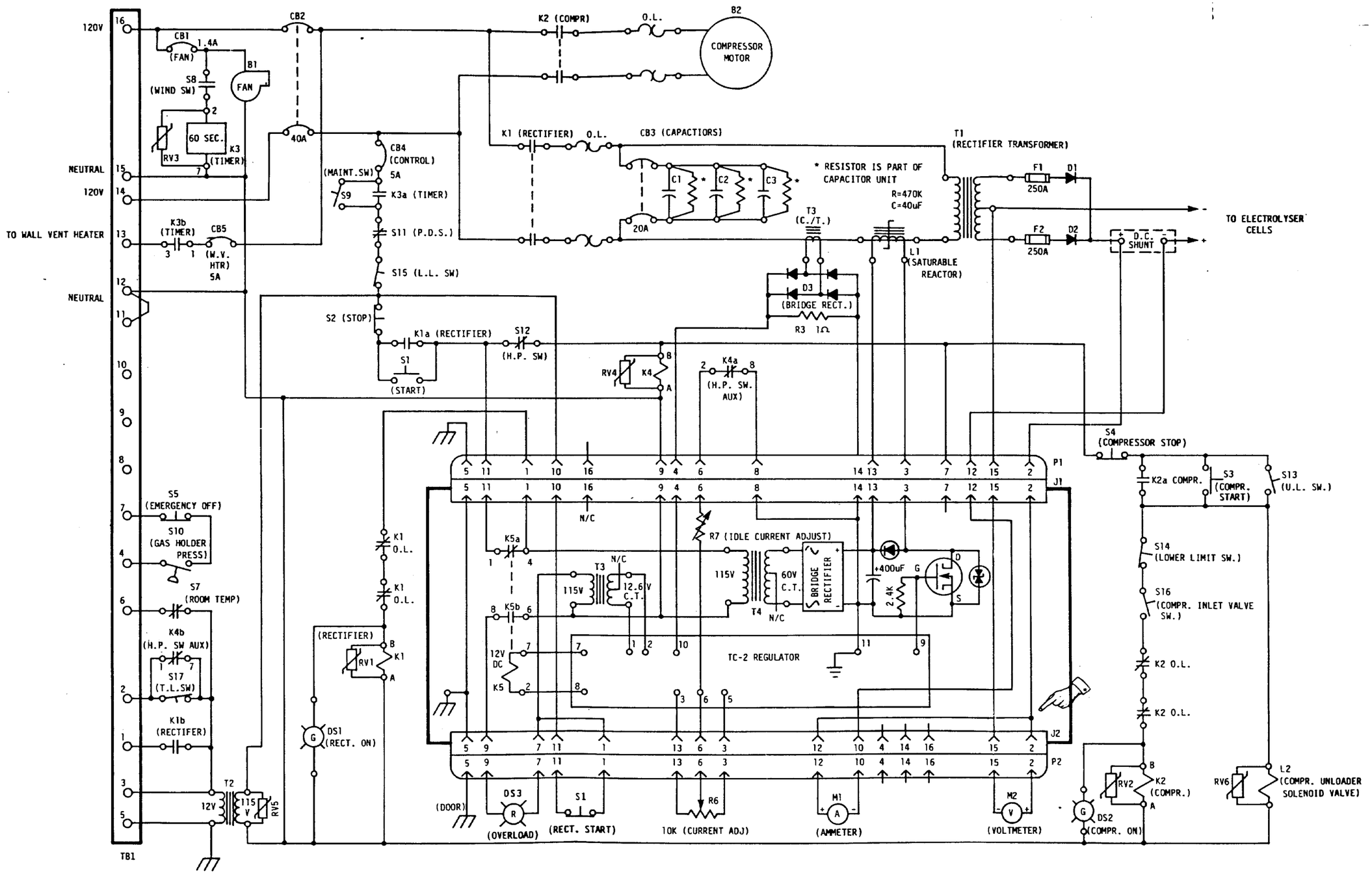



Figure 7-4 Circuit Diagram
Electrolyser M20-AES

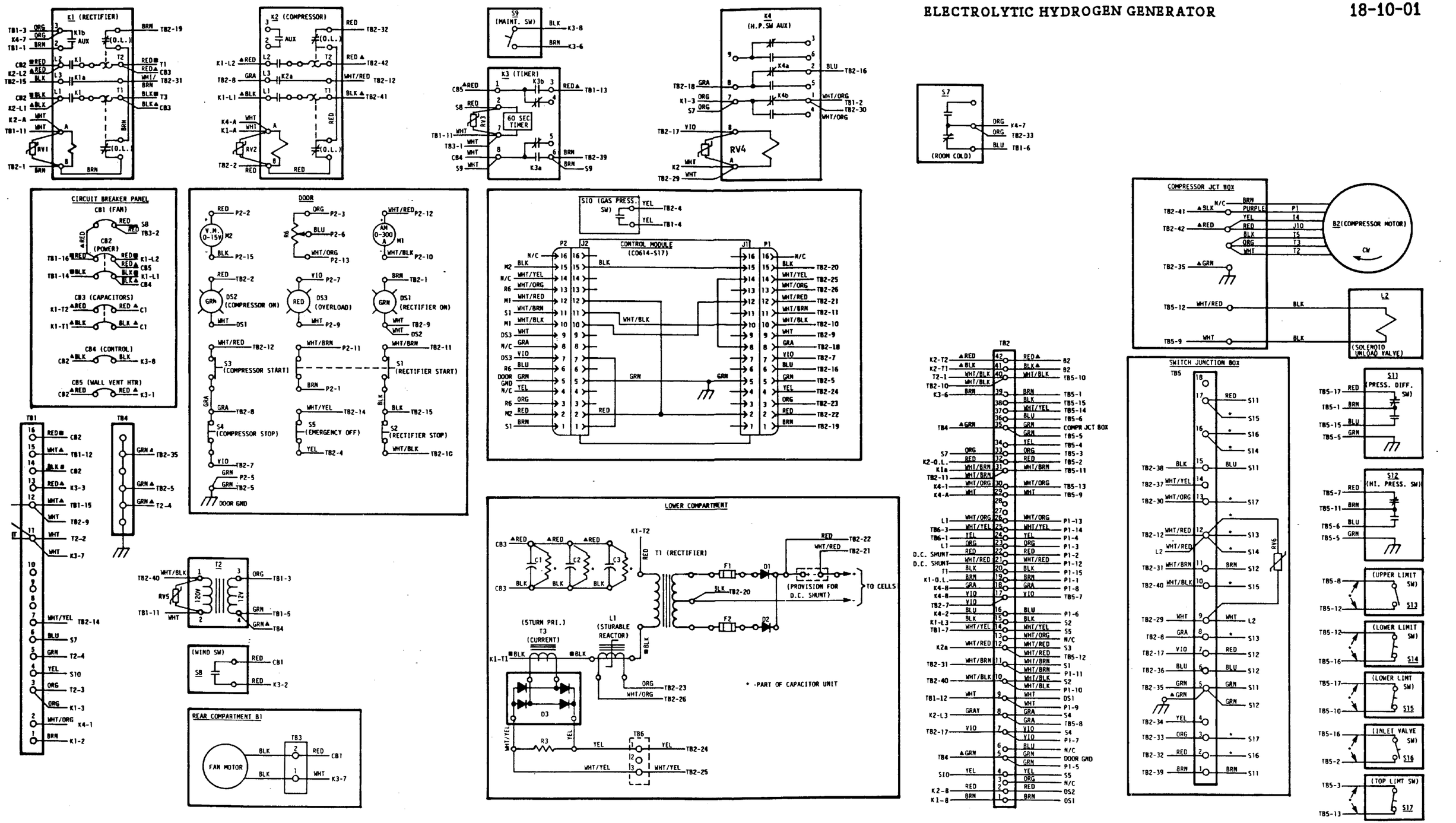



**Figure 7-5 Wiring Diagram**
**Electrolyser M20-AES**

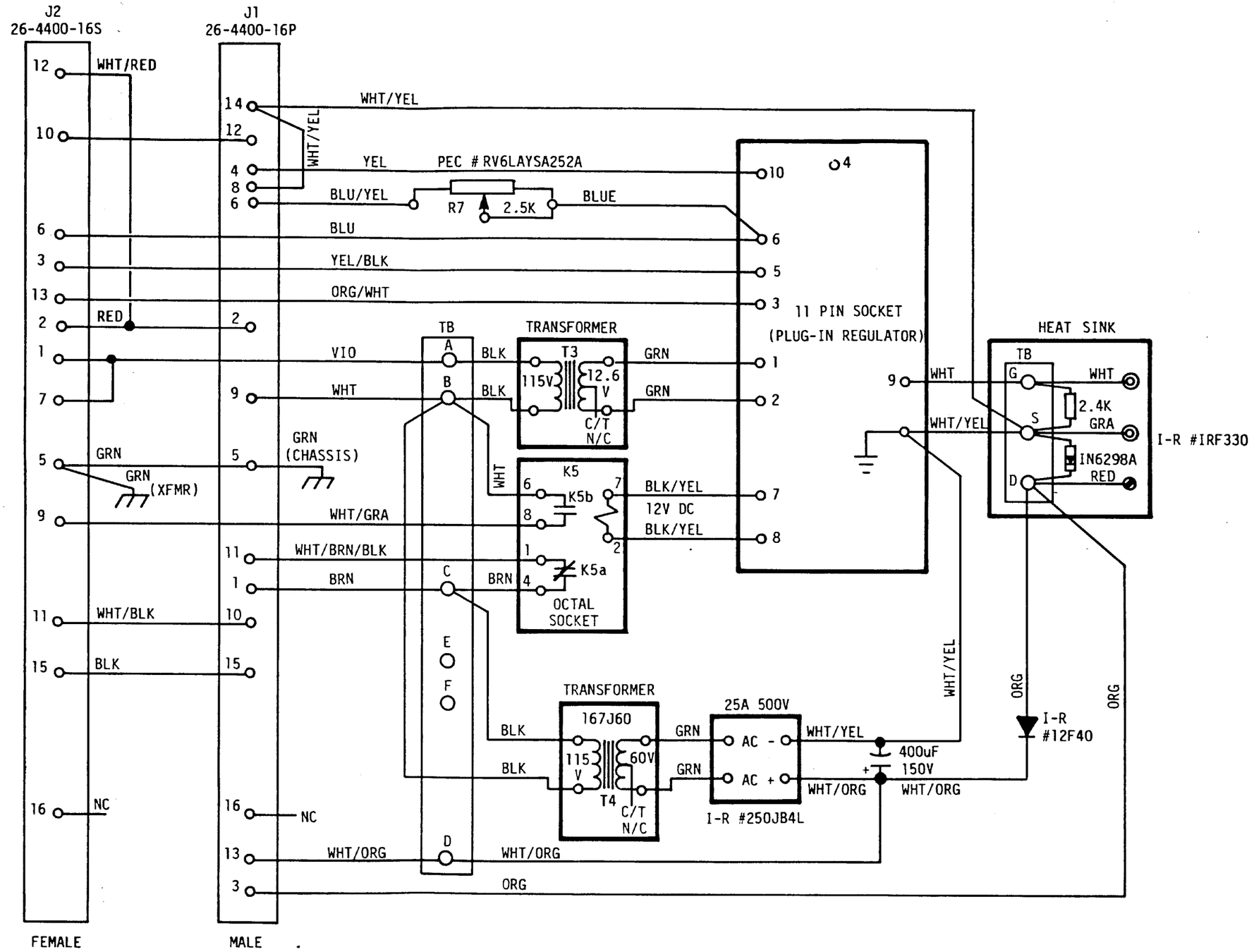



Figure 7-6 Control Module Wiring, Electrolyser M20-AES

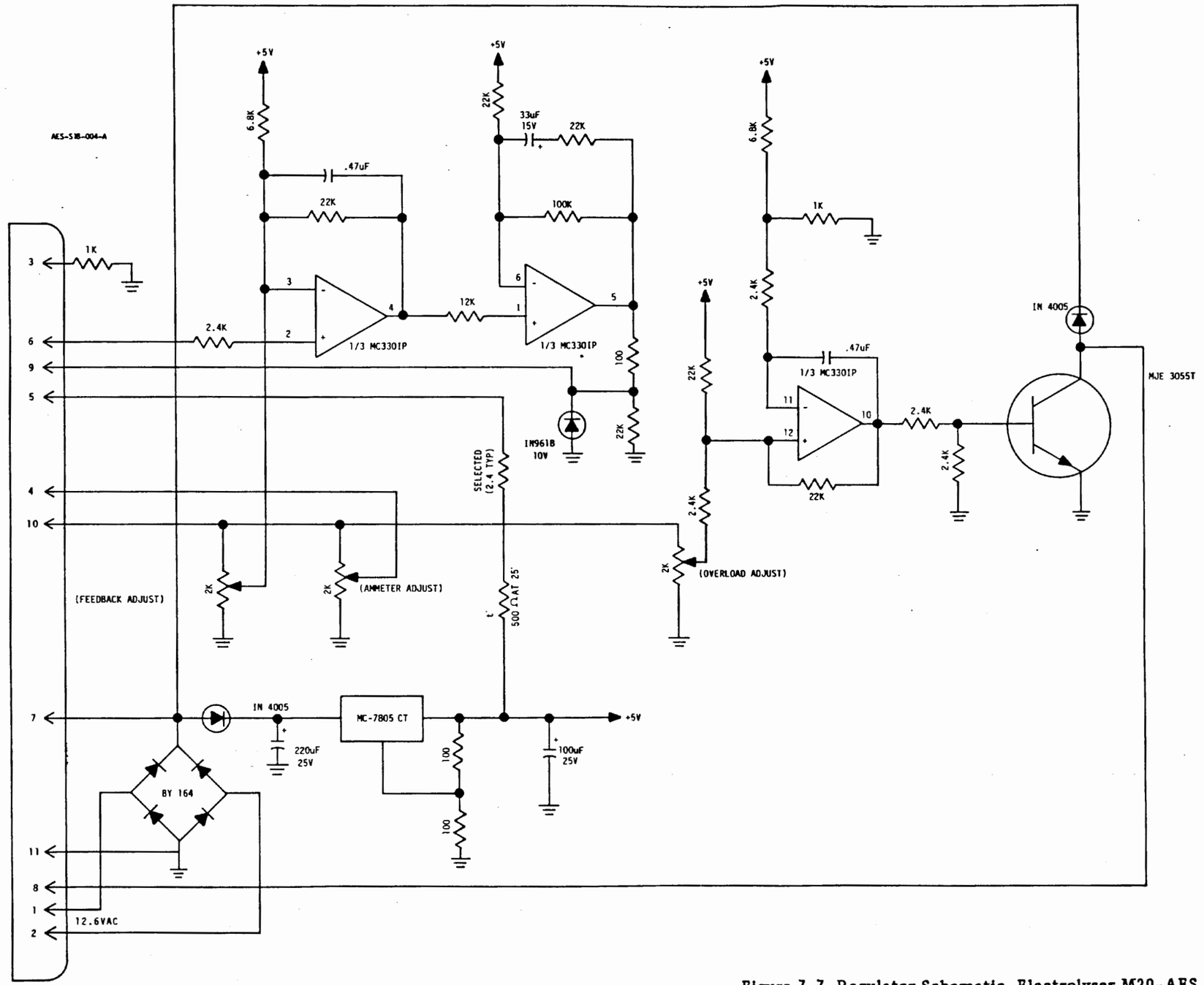



Figure 7-7 Regulator Schematic, Electrolyser M20-AES

# DOCUMENT IMPROVEMENT PROPOSAL

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