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Approval and Issuance Status Indeterminate

PART B PERMIT APPLICATION

1706-KE WASTE TREATMENT SYSTEM

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FOREWORD

The U.S. Department of Energy, Richland Operations Office (DOE-RL) Part B Permit Application for the Hanford Site consists of separate permit applications for the following hazardous waste treatment, storage, and disposal units:

1. Nonradioactive Dangerous Waste Landfill and Storage Facilities
2. Alkali Metal Treatment and Storage Facilities
3. Low-Level Burial Grounds and Retrievable Storage Facilities
4. 1324-N Surface Impoundment
5. 1706-KE Waste Treatment System

The following facilities are known to have received hazardous waste. These facilities will continue to operate, receiving only non-regulated wastes, and are described in a closure/post-closure plan:

1. 216-B-3 Pond
2. 216-A-29 Ditch
3. 216-B-63 Trench
4. 2101-M Pond
5. 100-D Ponds
6. 1324-NA Percolation Pond (closure plan only)
7. 300 Area Process Trenches

In addition, the following hazardous waste treatment, storage, and disposal units will be closed under interim status and have been described in a closure and/or post-closure plan:

1. Solar Evaporation Basins (closure/post-closure plan)

2. Solvent Evaporator (closure plan only)

3. 1301-N Liquid Waste Disposal Facility (closure/post-closure plan)

Each separate permit application and closure/post-closure plan provides a complete description of the hazardous waste management activities as required in the Washington Administrative Code (WAC) 173-303-806, Title 40 Code of Federal Regulations (CFR) Part 270 Subpart B, and WAC 173-303-400 (40 CFR 265 Subpart G), respectively. It is anticipated that each separate Part B permit application will be reviewed individually and will undergo subsequent revisions prior to acceptance by the State of Washington Department of Ecology (WDOE) or the U. S. Environmental Protection Agency (EPA), Region X.

At the time this document was prepared, the EPA had not authorized the State of Washington to regulate radioactive mixed wastes under the Resource Conservation Recovery Act (RCRA) and EPA indicated in a July 3, 1986, Federal Register Notice that currently authorized state programs do not apply to radioactive mixed wastes (51 Federal Register 24504). Neither the EPA nor the State of Washington have regulations which specifically address radioactive mixed wastes and it is currently uncertain how such wastes will be regulated. However, since the State of Washington has applied to EPA for authority to regulate radioactive mixed wastes, this plan has been written to existing state regulation on the assumption that the state will be authorized to regulate these wastes before the plan is acted upon. If this expectation does not occur, or if specific regulations addressing radioactive mixed wastes are adopted, any necessary changes to this plan will be made by amendment.

The following submittal contains the DOE-RL Part B Permit Application for the 1706-KE Waste Treatment System.

WP #9032A

(Pr — in areas are spaced for extra type, i.e., 12 characters/inch).

FORM 3

DANGEROUS WASTE PERMIT APPLICATION

I. EPA/STATE I.D. NUMBER: W A 7 8 9 0 0 0 8 9 6 7

FOR OFFICIAL USE ONLY

APPLICATION APPROVED	DATE RECEIVED (mo., day, & yr.)	COMMENTS

II. FIRST OR REVISED APPLICATION

Place an "X" in the appropriate box in A or B below (mark one box only) to indicate whether this is the first application you are submitting for your facility or a revised application. If this is your first application and you already know your facility's EPA/STATE I.D. Number, or if this is a revised application, enter your facility's EPA/STATE I.D. Number in Section I above.

A. FIRST APPLICATION (place an "X" below and provide the appropriate date)

☐ 1. EXISTING FACILITY (See instructions for definition of "existing" facility. Complete item below.)

☒ 2. NEW FACILITY (Complete item below.)

MO	DAY	YR	
			FOR EXISTING FACILITIES, PROVIDE THE DATE (mo., day, & yr.) OPERATION BEGAN OR THE DATE CONSTRUCTION COMMENCED (use the boxes to the left)

MO	DAY	YR	
0 7	1 1	8 6	FOR NEW FACILITIES, PROVIDE THE DATE (mo., day, & yr.) OPERATION BEGAN OR IS EXPECTED TO BEGIN

B. REVISED APPLICATION (place an "X" below and complete Section I above)

☒ 1. FACILITY HAS AN INTERIM STATUS PERMIT

☐ 2. FACILITY HAS A FINAL PERMIT

III. PROCESSES — CODES AND DESIGN CAPACITIES

A. PROCESS CODE — Enter the code from the list of process codes below that best describes each process to be used at the facility. Ten lines are provided for entering codes. If more lines are needed, enter the code(s) in the space provided. If a process will be used that is not included in the list of codes below, then describe the process (including its design capacity) in the space provided on the (Section III-C).

B. PROCESS DESIGN CAPACITY — For each code entered in column A enter the capacity of the process.
1. AMOUNT — Enter the amount.
2. UNIT OF MEASURE — For each amount entered in column B(1), enter the code from the list of unit measure codes below that describes the unit of measure used. Only the units of measure that are listed below should be used.

PROCESS	PROCESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY
Storage:		
CONTAINER (barrel, drum, etc.)	S01	GALLONS OR LITERS
TANK	S02	GALLONS OR LITERS
WASTE PILE	S03	CUBIC YARDS OR CUBIC METERS
SURFACE IMPOUNDMENT	S04	GALLONS OR LITERS
Disposal:		
INJECTION WELL	D80	GALLONS OR LITERS
LANDFILL	D81	ACRE-FEET (the volume that would cover one acre to a depth of one foot) OR HECTARE-METER
LAND APPLICATION	D82	ACRES OR HECTARES
OCEAN DISPOSAL	D83	GALLONS PER DAY OR LITERS PER DAY
SURFACE IMPOUNDMENT	D84	GALLONS OR LITERS

PROCESS	PROCESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY
Treatment:		
TANK	T01	GALLONS PER DAY OR LITERS PER DAY
SURFACE IMPOUNDMENT	T02	GALLONS PER DAY OR LITERS PER DAY
INCINERATOR	T03	TONS PER HOUR OR METRIC TONS PER HOUR; GALLONS PER HOUR OR LITERS PER HOUR
OTHER (Use for physical, chemical, thermal or biological treatment processes not occurring in tanks, surface impoundments or incinerators. Describe the processes in the space provided; Section III-C.)	T04	GALLONS PER DAY OR LITERS PER DAY

UNIT OF MEASURE	UNIT OF MEASURE CODE
GALLONS	G
LITERS	L
CUBIC YARDS	Y
CUBIC METERS	C
GALLONS PER DAY	U
LITERS PER DAY	V
TONS PER HOUR	D
METRIC TONS PER HOUR	W
GALLONS PER HOUR	E
LITERS PER HOUR	H
ACRE-FEET	A
HECTARE-METER	F
ACRES	B
HECTARES	Q

EXAMPLE FOR COMPLETING SECTION III (shown in line numbers X-1 and X-2 below): A facility has two storage tanks, one tank can hold 200 gallons and the other can hold 400 gallons. The facility also has an incinerator that can burn up to 20 gallons per hour.

LINE NUMBER	A. PROCESS CODE (from list above)	B. PROCESS DESIGN CAPACITY 1. AMOUNT (specify)	2. UNIT OF MEASURE (enter code)	FOR OFFICIAL USE ONLY	LINE NUMBER	A. PROCESS CODE (from list above)	B. PROCESS DESIGN CAPACITY 1. AMOUNT (specify)	2. UNIT OF MEASURE (enter code)	FOR OFFICIAL USE ONLY
X-1	S 0 2	600	G		5	S 0 2	96	G	
X-2	T 0 3	20	E		6	S 0 1	1,000	G	
1	S 0 2	550	G		7				
2	T 0 1	550	G		8				
[illegible]	T 0 4	720	E		9				
4	T 0 4	30	G		10				

Continued from the front

III. PROCESSES (continued)

C. SPACE FOR ADDITIONAL PROCESS CODES OR FOR DESCRIBING OTHER PROCESS (code "T04"). FOR EACH PROCESS ENTERED HERE INCLUDE DESIGN CAPACITY.

The 1706-KE Waste Treatment System consists of a 550 gallon waste accumulation tank, a cubic foot mixed-bed resin ion exchange column, a 30 gallon evaporation unit, a 96 gallon condensate collection tank, and a container storage area capable of holding up to fifteen 55 gallon containers.

Waste generated in the 1706-KE Building will be neutralized in the accumulation tank and then transferred from the waste accumulation tank to the ion exchange column and continuously recirculated to remove the ionic constituents from the waste stream. The wastes will then be transferred to the evaporation unit. This unit will be heated, and the liquid wasted boiled to steam. The steam will be condensed and collected in a 96 gallon condensate collection tank. Exhaust from the evaporation process will be passed through a carbon filter and a HEPA filter prior to discharge.

The 1706-KE Waste Treatment System is used to treat Radioactive mixed wastes generated in the laboratories of the 1706-KE Building.

IV. DESCRIPTION OF DANGEROUS WASTES

A. DANGEROUS WASTE NUMBER — Enter the four digit number from Chapter 173-303 WAC for each listed dangerous waste you will handle. If you handle dangerous wastes which are not listed in Chapter 173-303 WAC, enter the four digit number(s) that describes the characteristics and/or the toxic contaminants of those dangerous wastes.

B. ESTIMATED ANNUAL QUANTITY — For each listed waste entered in column A estimate the quantity of that waste that will be handled on an annual basis. For each characteristic or toxic contaminant entered in column A estimate the total annual quantity of all the non—listed waste(s) that will be handled which possess that characteristic or contaminant.

C. UNIT OF MEASURE — For each quantity entered in column B enter the unit of measure code. Units of measure which must be used and the appropriate codes are:

ENGLISH UNIT OF MEASURE	CODE	METRIC UNIT OF MEASURE	CODE
POUNDS	P	KILOGRAMS	K
TONS	T	METRIC TONS	M

If facility records use any other unit of measure for quantity, the units of measure must be converted into one of the required units of measure taking into account the appropriate density or specific gravity of the waste.

D. PROCESSES

1. PROCESS CODES:

For listed dangerous waste: For each listed dangerous waste entered in column A select the code(s) from the list of process codes contained in Section III to indicate how the waste will be stored, treated, and/or disposed of at the facility.

For non—listed dangerous wastes: For each characteristic or toxic contaminant entered in Column A, select the code(s) from the list of process codes contained in Section III to indicate all the processes that will be used to store, treat, and/or dispose of all the non—listed dangerous wastes that possess that characteristic or toxic contaminant.

Note: Four spaces are provided for entering process codes. If more are needed: (1) Enter the first three as described above; (2) Enter "U00" in the extreme right box of Item IV-D(1); and (3) Enter in the space provided on page 4, the line number and the additional code(s).

2. PROCESS DESCRIPTION: If a code is not listed for a process that will be used, describe the process in the space provided on the form.

NOTE: DANGEROUS WASTES DESCRIBED BY MORE THAN ONE DANGEROUS WASTE NUMBER — Dangerous wastes that can be described by more than one Waste Number shall be described on the form as follows:

1. Select one of the Dangerous Waste Numbers and enter it in column A. On the same line complete columns B, C, and D by estimating the total annual quantity of the waste and describing all the processes to be used to treat, store, and/or dispose of the waste.
2. In column A of the next line enter the other Dangerous Waste Number that can be used to describe the waste. In column D(2) on that line enter "included with above" and make no other entries on that line.
3. Repeat step 2 for each other Dangerous Waste Number that can be used to describe the dangerous waste.

EXAMPLE FOR COMPLETING SECTION IV *(shown in line numbers X-1, X-2, X-3, and X-4 below)* — A facility will treat and dispose of an estimated 900 pounds per year of chrome shavings from leather tanning and finishing operation. In addition, the facility will treat and dispose of three non—listed wastes. Two wastes are corrosive only and there will be an estimated 200 pounds per year of each waste. The other waste is corrosive and ignitable and there will be an estimated 100 pounds per year of that waste. Treatment will be in an incinerator and disposal will be in a landfill.

LINE	A. DANGEROUS WASTE NO. (enter code)	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE (enter code)	D. PROCESSES 1. PROCESS CODES (enter)	D. PROCESSES 2. PROCESS DESCRIPTION (if a code is not entered in D(1))
X-1	K 0 5 4	900	P	T 0 3 D 8 0	
X-2	D 0 0 2	400	P	T 0 3 D 8 0	
X-3	D 0 0 1	100	P	T 0 3 D 8 0	
X-4	D 0 0 2			T 0 3 D 8 0	included with above

Continued from page 2.
NOTE. Photocopy this page before completing if you have more than 26 wastes to list.

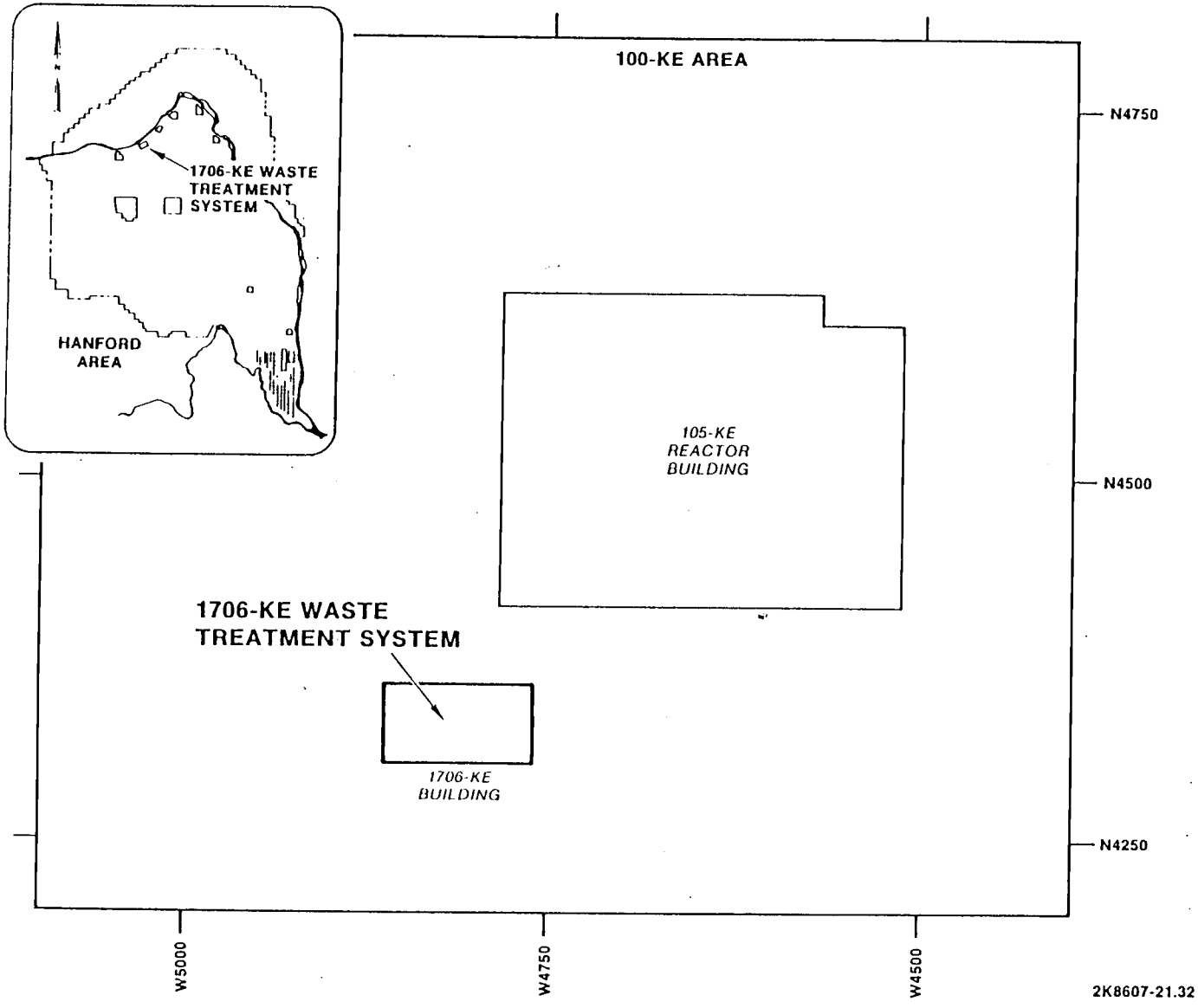
I.D. NUMBER (enter from page 1)
WIA 7 8 9 0 0 0 8 9 6 7

IV. DESCRIPTION OF DANGEROUS WASTES (continued)

LINE NO.	A. DANGEROUS WASTE NO. (enter code)	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE (enter code)	D. PROCESSES 1. PROCESS CODES (enter)	D. PROCESSES 2. PROCESS DESCRIPTION (if a code is not entered in D(1))
1	W T 0 2	15,000	P	S 0 1 S 0 2 T 0 4	Neutralization Ion exchange/ evaporation/storage
2	0 0 0 2	15,000	P		Included with above
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					

SECTION V - FACILITY DRAWINGS

1706-KE WASTE TREATMENT SYSTEM

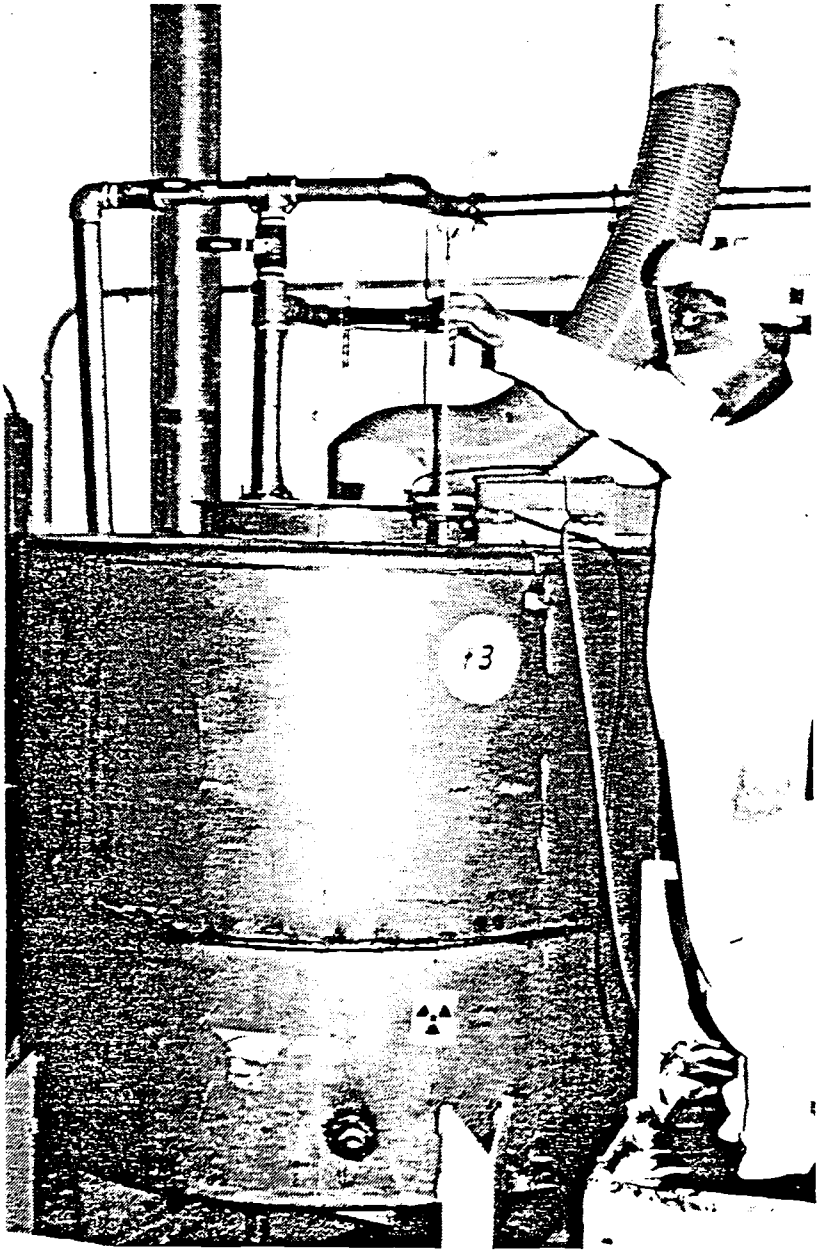


WA7890008967

SECTION VI - PHOTOGRAPHS

WA7890008967

1706-KE WASTE TREATMENT SYSTEM



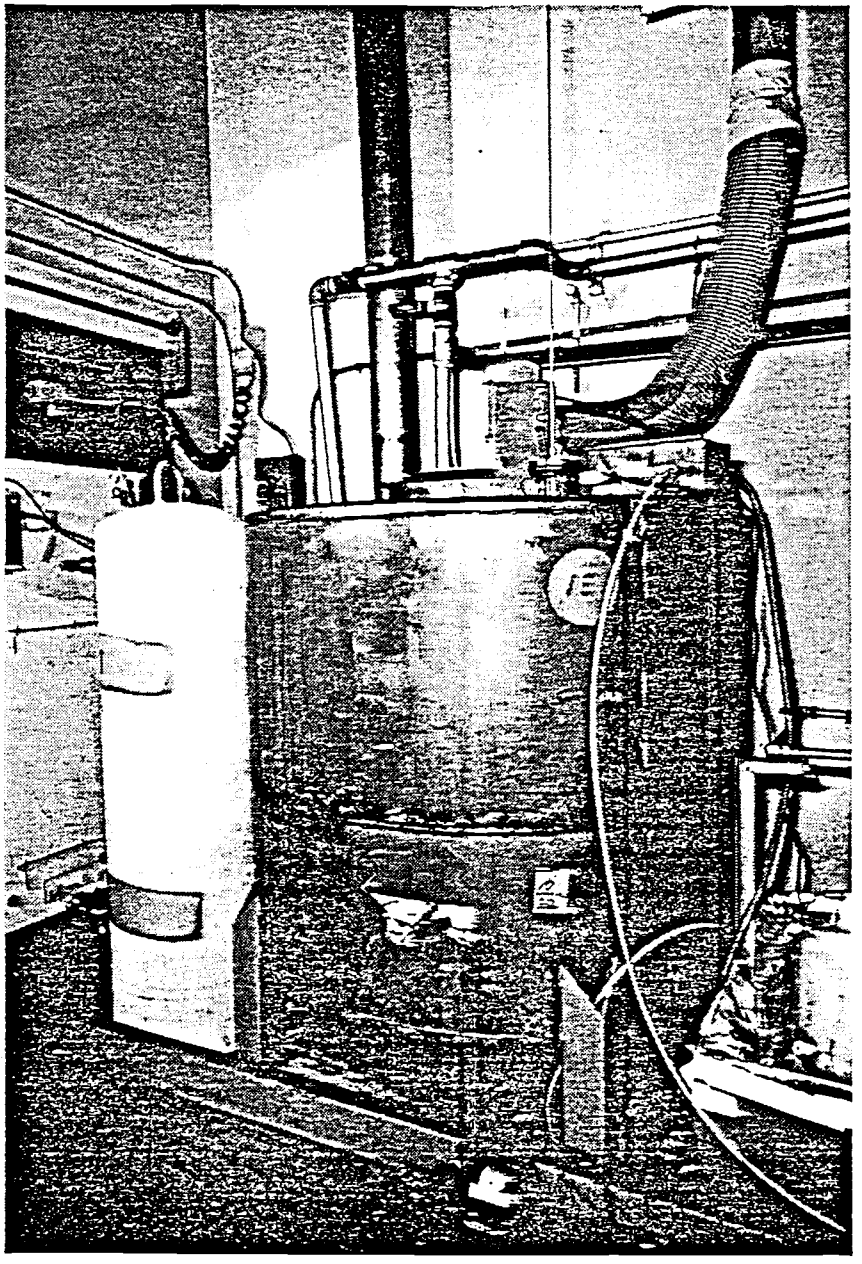
WASTE ACCUMULATION TANK

Longitude	Latitude
119° 35'34, 192"	46° 38'57.225"

(PHOTO TAKEN 1986)

2K8607-21.23

1706-KE WASTE TREATMENT SYSTEM

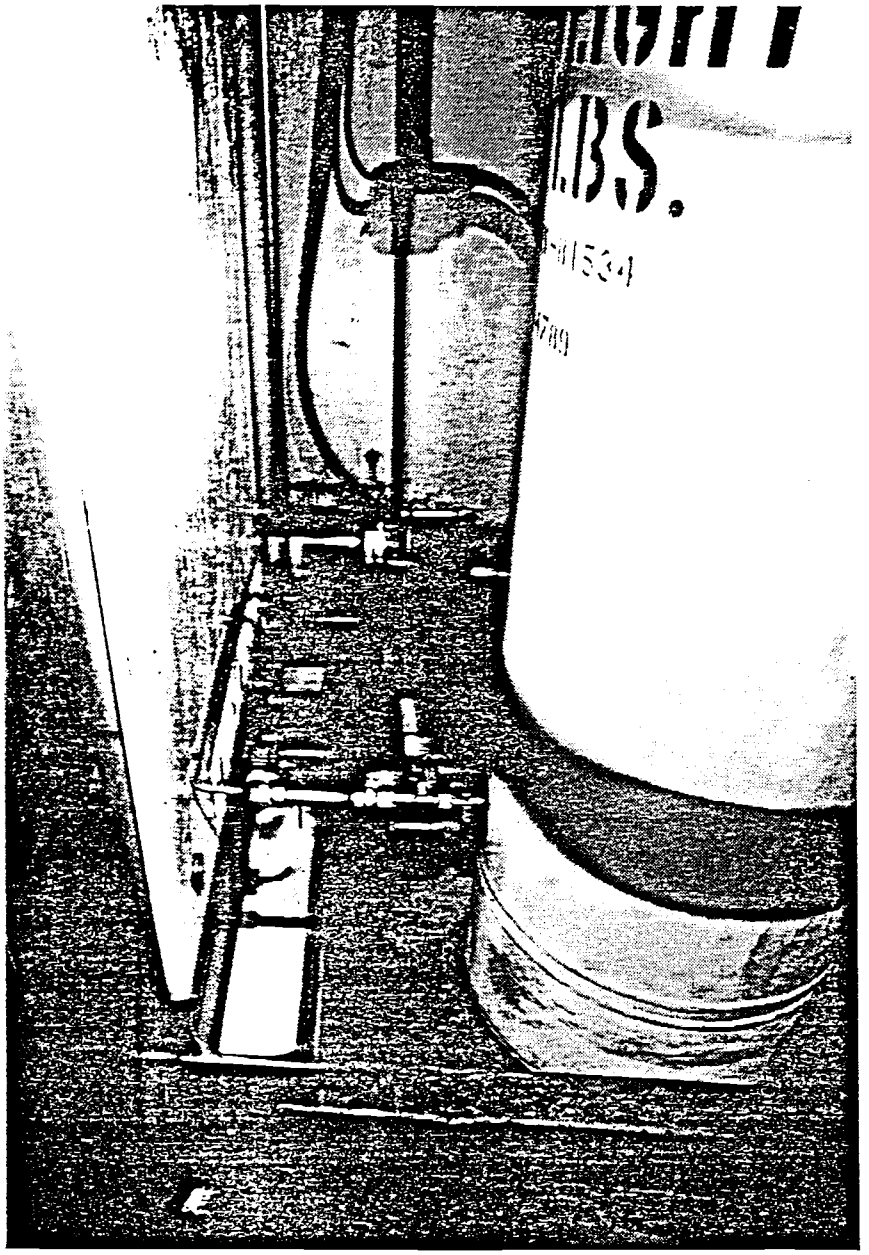


ION EXCHANGE COLUMN
AND WASTE ACCUMULATION TANK

(PHOTO TAKEN 1987)

2K8701-6.42

1706-KE WASTE TREATMENT SYSTEM



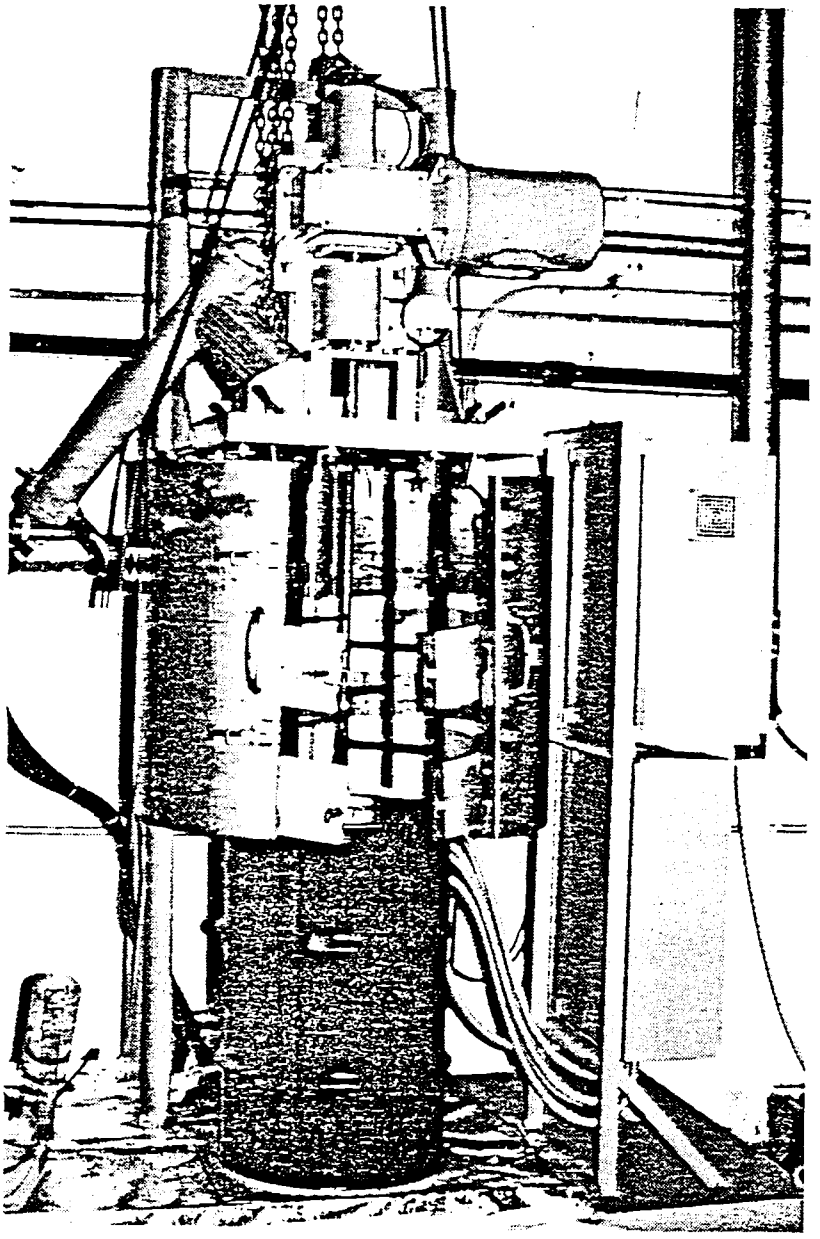
ION EXCHANGE COLUMN AND ASSOCIATED PIPING

(PHOTO TAKEN 1987)

2K8701-6.41

WA7890008967

1706-KE WASTE TREATMENT SYSTEM



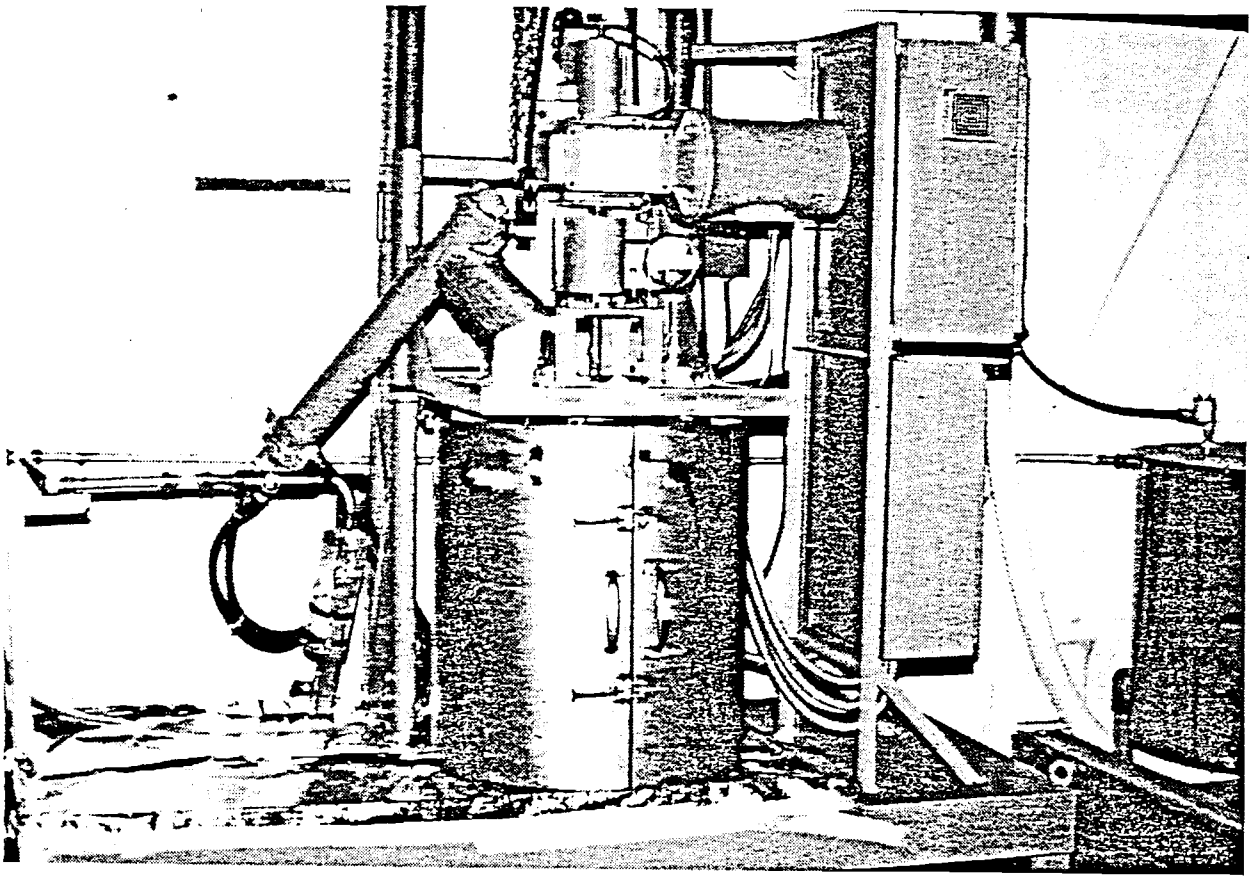
SOLIDIFICATION UNIT SHOWN IN UP POSITION

(PHOTO TAKEN 1986)

2K8607-21.21

WA7890008967

1706-KE WASTE TREATMENT SYSTEM



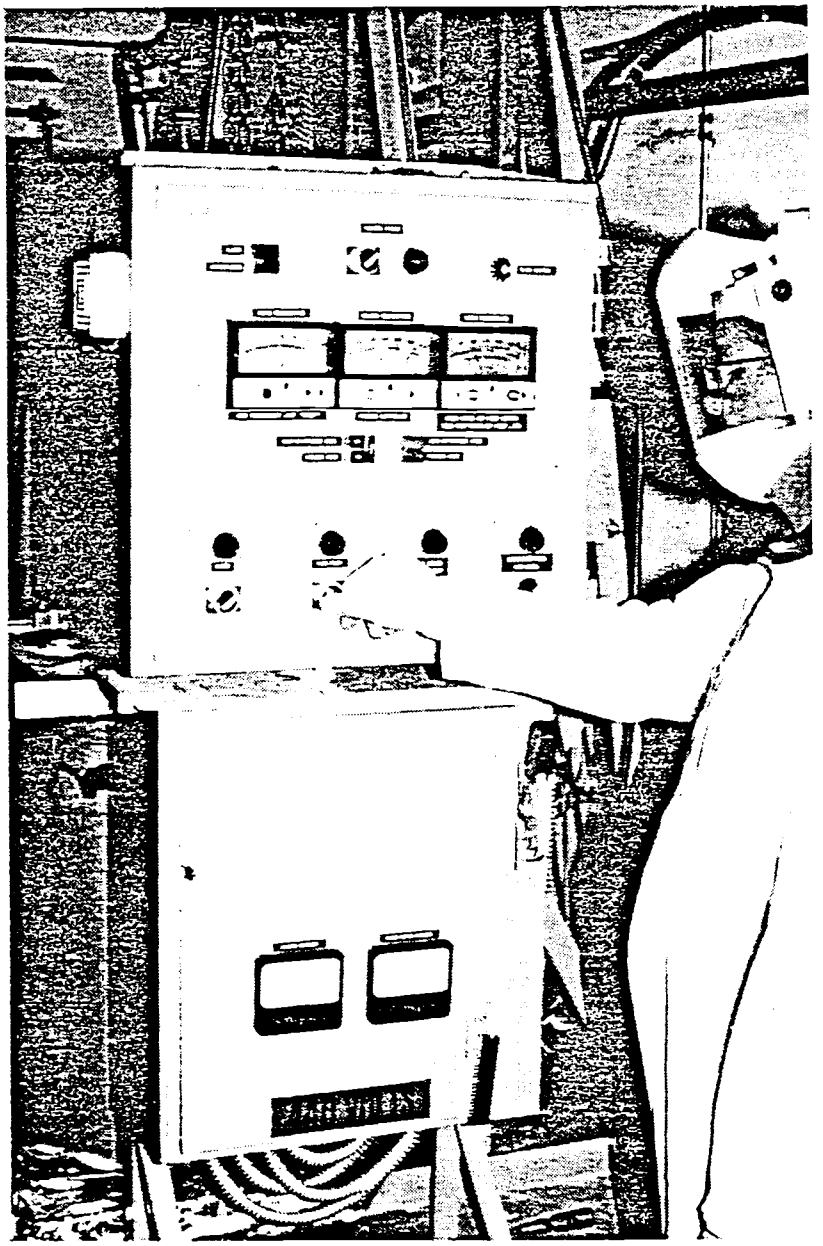
SHOWN IN DOWN POSITION EVAPORATING WASTE

(PHOTO TAKEN 1986)

2K8607-21.20

WA7890008967

1706-KE WASTE TREATMENT SYSTEM



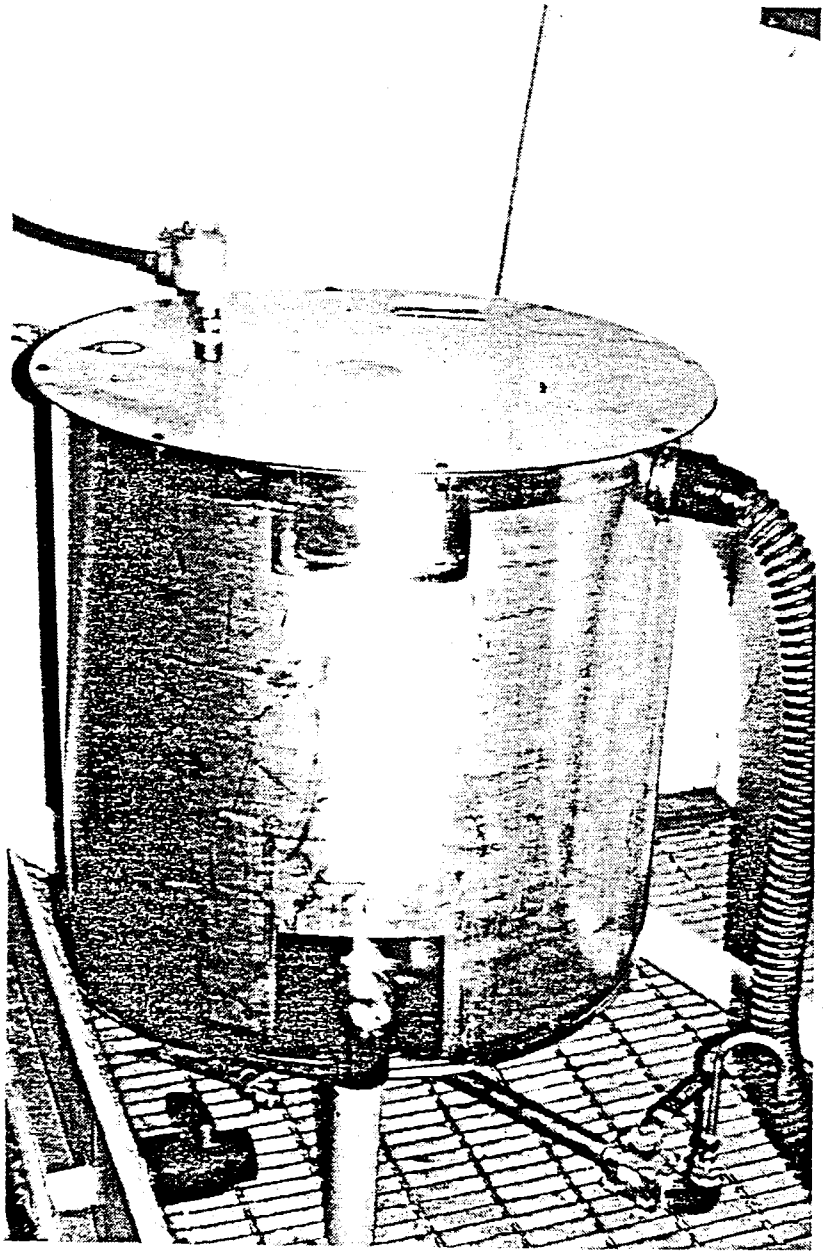
SYSTEM CONTROL PANEL

(PHOTO TAKEN 1986)

2K8607-21.22

WA7890008967

1706-KE WASTE TREATMENT SYSTEM

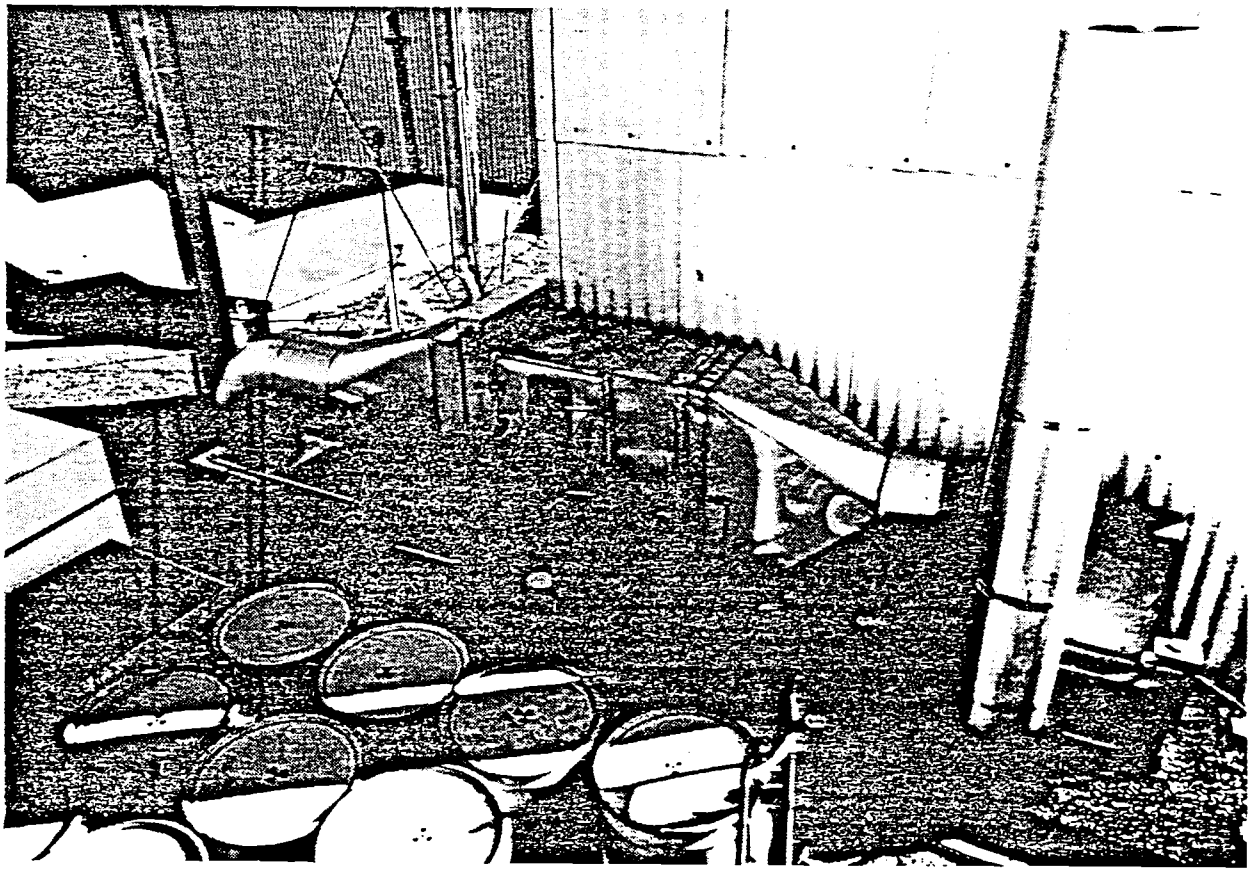


CONDENSATE TANK

(PHOTO TAKEN 1986)

2K8607-21.19

1706-KE WASTE TREATMENT SYSTEM



EXHAUST FILTER SYSTEM (PHOTO TAKEN 1987)

2K8701-6.43

SECTION A

PART A APPLICATION

A-1 INTRODUCTION

The 1706-KE Waste Treatment System is a treatment unit which will be used to treat radioactive and radioactive mixed wastes. These wastes are generated in the laboratories and test facilities of the 1706-KE Chemistry and Waste Treatment Technology Building. The wastes will be transported via polyethylene tubing from a waste transfer station to a 550-gallon waste accumulation tank. All wastes accumulated in the tank will be neutralized to a pH of approximately 7.0 standard units upon admittance to the tank. This waste stream will then be passed through an ion exchange column to remove ionic constituents from the waste.

The wastes will then be transferred to the evaporation unit. This unit will be heated, and the liquids and the volatile materials will be vaporized. The vapor will be condensed, and the water will be collected in a condensate tank. The volatile airborne materials will be filtered through a carbon filter and a HEPA filter system. The solid materials remaining in the evaporation unit will be contained for proper disposal as a radioactive mixed waste.

Volume 2 of the U.S. Department of Energy (DOE-RL) Part A Permit Application was prepared for submittal to the State of Washington Department of Ecology (WDOE) and the U.S. Environmental Protection Agency (EPA), Region X, on August 15, 1986. It contained waste designation and treatment process information for the 1706-KE Waste Treatment System, which is located in the 100-KE Area of the Hanford Site.

The 1706-KE Waste Treatment System is a dangerous waste treatment facility which was put into operation in July of 1986. Since a Part A Permit Application was submitted to the EPA and WDOE in August of 1986, the 1706-KE

Waste Treatment Facility currently has interim status, and will continue to operate under interim status until the facility receives a final facility permit.

The 1706-KE Waste Treatment System will not be operated again until all system components meet the regulatory requirements of WAC 173-303 and 40 CFR 264 and an operating procedure has been written for the system.

A-2 PART A APPLICATION

The following revised Part A Permit Application contains waste designation information and waste treatment process codes for the 1706-KE Waste Treatment System. This revised Part A Application is being submitted to the EPA and WDOE in April, 1987. The original Part A Application was submitted to WDOE on August 15, 1986.

The 1706-KE Waste Treatment System has been modified since the original submittal of that Part A Application. An ion exchange column has been added to the system to remove the ionic waste constituents.

The liquid wastes from the ion exchange column will be transferred to the solidification unit. The solidification unit will now be used only for evaporation of the liquid wastes. The condensate from the evaporation process will be collected in a condensate collection tank. The contents of this tank will be transferred into 55-gallon containers and stored in a new container storage area until samples of the condensate have been analyzed and determined to be nonhazardous and nonradioactive.

These modifications to the System were necessary to comply with the requirements of 40 CFR 264 and WAC 173-303.

WP #9136A

PART A

DANGEROUS WASTE PERMIT FORMS

(FORMS 1 and 3)

WASHINGTON STATE
DANGEROUS WASTE PERMIT
GENERAL INFORMATION

Permit Application Process

There are two parts to a Dangerous Waste Permit Application—Part A and Part B. Part A consists of Form 1 and Form 3. Part B requires detailed site—specific information such as geologic, hydrologic, and engineering data. WAC 173-303-806 specifies the information that will be required from dangerous waste management facilities in Part B.

Operation During Interim Status

Part A of the permit application defines the processes to be used for treatment, storage, and disposal of dangerous wastes; the design capacity of such processes, and the specific dangerous wastes to be handled at a facility during the interim status period. Once Part A is submitted to the Department of Ecology, changes in the dangerous wastes handled, changes in design capacities, changes in processes, and changes in ownership or operational control at a facility during the interim status period may only be made in accordance with the procedures in WAC 173-303-820. Changes in quantity of waste handled at a facility during interim status can be made without submitting a revised Part A provided the quantity does not exceed the design capacities of the processes specified in Part A of the permit application. Failure to furnish all information required to process a permit application is grounds for termination of an interim status permit.

Confidential Information

All information submitted in this form will be subject to public disclosure, to the extent provided by RCRA and the Freedom of Information Act, 5 U.S.C. Section 552, and EPA's Business Confidentiality Regulations, 40 CFR Part 2 (*see especially 40 CFR 2.305*), and will be subject to the State of Washington Public Records Act chapter 42.17 RCW and chapter 43.21A-160 RCW. Persons filing this form may make claims of confidentiality. Such claims must be clearly indicated by marking "confidential" on the specific information on the form for which confidential treatment is requested or on any attachments, and must be accompanied, at the time of filing, by a written substantiation of the claim, by answering the following questions:

Confidential Information (continued)

A. Which portions of the information do you claim are entitled to confidential treatment?

B. For how long is confidential treatment desired for this information?

C. What measures have you taken to guard against undesired disclosure of the information to others?

D. To what extent has the information been disclosed to others, and what precautions have been taken in connection with that disclosure?

E. Has the Department of Ecology, EPA or any other Federal or State agency made a pertinent confidentiality determination? If so, what would those harmful effects be and why should they be viewed as substantial? Explain the causal relationship between disclosure and the harmful effects.

If no claim of confidentiality or no substantiation accompanies the information when it is submitted, EPA or the department may make the information available to the public without further notice to the submitter.

Definitions

Terms used in these instructions and in this form are defined in the Definitions section of the Dangerous Waste Regulation, chapter 173-303 WAC.

FORM 1—INSTRUCTIONS

This form must be completed by all applicants.

Completing This Form

Please type or print. If you print, place each character between the marks. Abbreviate if necessary to stay within the number of characters allowed for each item. Use one space for breaks between words, but not for punctuation marks unless they are needed to clarify your response.

Section I

Space is provided at the upper right hand corner of Form 1 for insertion of your EPA/State identification number. If you have an existing facility, enter your identification number. If you don't have an EPA/State identification number, please contact the Department of Ecology (206) 459-6303 and one will be provided for you. If your facility is new (not yet constructed), leave this item blank.

Section II

Enter the facility's official or legal name. Do not use a colloquial name.

Section III

Give the name, title, and work telephone number of a person who is thoroughly familiar with the operation of the facility and with the facts reported in this application and who can be contacted if necessary.

Section IV

Give the complete mailing address of the office where correspondence should be sent. This often is not the address used to designate the location of the facility or activity.

Section V

Give the address or location of the facility identified in Section III of this form. If the facility lacks a street name or route number, give the most accurate alternative geographic information (e.g., section number or quarter section number from county records or at intersection of Rts. 425 and 22).

Section VI

List, in descending order of significance, the four 4-digit standard industrial classification (SIC) codes which best describe your facility in terms of the principal products or services you produce or provide. Also, specify each classification in words. These classifications may differ from the SIC codes describing the operation generating the dangerous wastes.

SIC code numbers are descriptions which may be found in the "Standard Industrial Classification Manual" prepared by the Executive Office of the President, Office of Management and Budget, which is available from the Government Printing Office, Washington, D.C. Use the current edition of the manual. If you have any questions concerning the appropriate SIC code for your facility, contact your Department of Ecology Regional office (see Table 1).

Table 1. Department of Ecology Regional Offices

Northwest Regional Office 4350 - 150th NE Redmond, Washington 98052 Tel: 206-885-1900	Southwest Regional Office 7272 Cleanwater Lane Olympia, Washington 98504 Tel: 206-753-2353
Eastern Regional Office East 103 Indiana Spokane, Washington 99207 Tel: 509-456-2926	Central Regional Office 3601 West Washington Yakima, Washington 98903 Tel: 509-575-2490

Section VII-A

Give the name, as it is legally referred to, of the person, firm, public organization, or any other entity which operates the facility described in this application. This may or may not be the same name as the facility. The operator of the facility is the legal entity which controls the facility's operation rather than the plant or site manager. Do not use a colloquial name.

Section VII-B

Indicate whether the entity which operates the facility also owns it by marking the appropriate box.

Section VII-C

Enter the appropriate letter to indicate the legal status of the operator of the facility. Indicate "public" for a facility solely owned by local government(s) such as a city, town, county, parish, etc.

Sections VII-D—H

Enter the telephone number and address of the operator identified in Item VII-A.

Section VIII

Indicate whether the facility is located on Indian lands.

Section IX

Provide a topographic map or maps of the area extending at least to one mile beyond the property boundaries of the facility which clearly show the following:

The legal boundaries of the facility;

The location and serial number of each of your existing and proposed intake and discharge structures;

All hazardous waste management facilities;

Each well where you inject fluids underground; and

All springs and surface water bodies in the area, plus all drinking water wells within ¼ mile of the facility which are identified in the public record or otherwise known to you.

If an intake or discharge structure, hazardous waste disposal site, or injection well associated with the facility is located more than one mile from the plant, include it on the map, if possible. If not, attach additional sheets describing the location of the structure, disposal site, or well, and identify the U.S. Geological Survey (or other) map corresponding to the location.

On each map, include the map scale, a meridian arrow showing north, and latitude and longitude at the nearest whole second. On all maps of rivers, show the direction of the current, and in tidal waters, show the directions of the ebb and flow tides. Use a 7-½ minute series map published by the U.S. Geological Survey, which may be obtained through the U.S. Geological Survey Offices listed below. If a 7-½ minute series map has not been published for your facility site, then you may use a 15 minute series map from the U.S. Geological Survey. If neither a 7-½ nor 15 minute series map has been published for your facility site, use a plat map or other appropriate map, including all the requested information; in this case, briefly describe land uses in the map area (e.g., residential, commercial).

You may trace your map from a geological survey chart, or other map meeting the above specifications. If you do, your map should bear a note showing the number or title of the map or chart it was traced from. Include the names of nearby towns, water bodies, and prominent points.

U.S.G.S. OFFICES	AREA SERVED
Western Mapping Center National Cartographic Information Center U.S.G.S. 345 Middlefield Road Menlo Park, Ca. 94025 Phone No. (415) 323-8111	Ariz., Calif., Hawaii, Idaho Nev., Oreg., Wash., American Samoa, Guam, and trust Territories

Section X

Briefly describe the nature of your business (e.g., products produced or services provided).

Section XI

For a corporation, by a principal executive officer of at least the level of vice president;

For partnership or sole proprietorship, by a general partner or the proprietor respectively; or

For a municipality, State, Federal, or other public facility, by either a principal executive officer or ranking elected official.

ECY 030-31 INSTR.

ECY -273-

FORM 1	State of Washington Department of Ecology	WASHINGTON STATE DANGEROUS WASTE PERMIT GENERAL INFORMATION (Read "Form 1 Instructions" before starting)	I. EPA/STATE I.D. NUMBER WA 7 8 9 0 0 0 8 9 6 7

II. NAME OF FACILITY

US DEPT OF ENERGY RICHLAND OPERATIONS OFFICE

III. FACILITY CONTACT

A. NAME & TITLE (last, first, & title)	B. PHONE (area code & no.)
FITZSIMMONS, T.R. ASSISTANT MGR SAFETY*	509 376 7387

IV. FACILITY MAILING ADDRESS

A. STREET OR P.O. BOX: PO BOX 550

B. CITY OR TOWN	C. STATE	D. ZIP CODE
RICHLAND	WA	99352

V. FACILITY LOCATION

A. STREET, ROUTE NO. OR OTHER SPECIFIC IDENTIFIER: HANFORD SITE

B. COUNTY NAME: BENTON

C. CITY OR TOWN	D. STATE	E. ZIP CODE	F. COUNTY CODE (if known)
RICHLAND	WA	99352	005

IV. SIC CODES (4-digit, in order of priority)

A. FIRST	B. SECOND
9711 (specify) NATIONAL SECURITY	8922 (specify) NUCLEAR NONCOMMERCIAL RESEARCH DEVELOPMENT AND EDUCATION
C. THIRD	**D. FOURTH**
9511 (specify) ADMINISTRATION AND GENERAL ECONOMICS PROGRAM	4911 (specify) STEAM - ELECTRIC GENERATOR

VII. OPERATOR INFORMATION

A. NAME: US DEPT OF ENERGY RICHLAND OPERATIONS

B. Is the name listed in Item VII-A also the owner? [X] YES [ ] NO

C. STATUS OF OPERATOR (Enter the appropriate letter into the answer box; if "Other", specify.)
F = FEDERAL, S = STATE, P = PRIVATE, M = PUBLIC (other than federal or state), O = OTHER (specify)
F (specify)

D. PHONE (area code & no.): 509 376 7387

E. STREET OR P.O. BOX: PO BOX 550

F. CITY OR TOWN	G. STATE	H. ZIP CODE
RICHLAND	WA	99352

VIII. INDIAN LAND

Is the facility located on Indian lands? [ ] YES [X] NO

COMPLETE BACK PAGE

*Office of Assistant Manager for Safety, Safeguards and Quality Assurance

ECY 030-31

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WA7890008967

IX. MAP

Attach to this application a topographic map of the area extending to at least one mile beyond property boundaries. The map must show the outline of the facility, the location of each of its existing and proposed intake and discharge structures, each of its hazardous waste treatment, storage, or disposal facilities, and each well where it injects fluids underground. Include all springs, rivers and other surface water bodies in the map area. See instructions for precise requirements.

X. NATURE OF BUSINESS *(provide a brief description)*

O NATIONAL DEFENSE NUCLEAR MATERIAL PRODUCTION

O ENERGY RESEARCH AND TECHNOLOGY DEVELOPMENT

O DEFENSE NUCLEAR WASTE MANAGEMENT

O BYPRODUCT STEAM, SOLD FOR ELECTRIC POWER GENERATION

O AND SIC 15: BUILDING CONSTRUCTION - GENERAL CONTRACTORS AND OPERATIVE BUILDERS

XI. CERTIFICATION *(see instructions)*

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this application and all attachments and that, based on my inquiry of those persons immediately responsible for obtaining the information contained in the application, I believe that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

A. NAME & OFFICIAL TITLE (type or print)	B. SIGNATURE	C. DATE SIGNED
T.R. FITZSIMMONS, ASST. MANAGER		

ECY 030-31 Reverse

ECL 5 278-

FORM 3—INSTRUCTIONS

Completing This Form

Please type or print. If you print place each character between the marks. Abbreviate if necessary to stay within the number of characters allowed for each item. Use one space for breaks between words, but not for punctuation marks unless they are needed to clarify your response.

Section I

Existing dangerous waste management facilities should enter their EPA/STATE Identification Number *(if known)*. New facilities should leave this item blank.

Section II

A. FIRST APPLICATION. If this is the first application that is being filed for the facility place an "X" in either the Existing Facility box or the New Facility box.

1. EXISTING FACILITY. Existing facilities are:

   a. Those facilities which received hazardous waste for treatment, storage, and/or disposal on or before November 19, 1980; or

   b. Those facilities for which construction had commenced on or before November 19, 1980. Construction had "commenced" only if:

      (1) The owner or operator had obtained all necessary Federal, State, and local preconstruction approvals or permits; and

      (2-a) A continuous physical, on—site construction program had begun *(facility design or other preliminary non—physical and non—site specific preparatory activities do not constitute an on—site construction program)*, or

      (2-b) The owner or operator had entered into contractual obligations *(options to purchase or contracts for feasibility, engineering, and design studies do not constitute contractual obligations)* which could not be cancelled or modified without substantial loss. Generally, a loss is deemed substantial if the amount an owner or operator must pay to cancel construction agreements or stop construction exceeds 10% of the total project cost.

   EXISTING FACILITY DATE. If the Existing Facility box is marked, enter the date dangerous waste operations began *(i.e., the date the facility began treating, storing, or disposing of hazardous waste)* or the date construction commenced.

2. NEW FACILITY. New facilities are all facilities for which construction commenced, or will commence, after November 19, 1980.

   NEW FACILITY DATE. If the New Facility box is marked, enter the date that operation began or is expected to begin.

B. REVISED APPLICATION. If this is a subsequent application that is being filed to amend data filed in a previous application, place an "X" in the appropriate box to indicate whether the facility has interim status or a permit.

1. FACILITY HAS AN INTERIM STATUS PERMIT. Place an "X" in this box if this is a revised application to make changes at a facility during the interim status period.

2. FACILITY HAS A FINAL PERMIT. Place an "X" in this box if this is a revised application to make changes at a facility for which a permit has been issued.

(NOTE. When submitting a revised application, applicants must resubmit in their entirety each item on the application for which changes are requested. In addition, Items I and IX [and Item X if applicable] must be completed. It is not necessary to resubmit information for other items that will not change).

ECY 030-31 INSTR. Form 3

ECL3A -271-

Section III

The information in Section III describes all the processes that will be used to treat, store, or dispose of dangerous waste at the facility. The design capacity of each process must be provided as part of the description. The design capacity of injection wells and landfills at existing facilities should be measured as the remaining, unused capacity. See the form for the detailed instructions to Section III.

Section IV

The information in Section IV describes all the dangerous wastes that will be treated, stored, or disposed at the facility. In addition, the processes that will be used to treat, store, or dispose of each waste and the estimated annual quantity of each waste must be provided. See the form for the detailed instructions to Section IV.

Section V

All existing facilities must include a drawing showing the general layout of the facility. This drawing should be approximately to scale and fit in the space provided on the form. This drawing should show the following:

The property boundaries of the facility;

The areas occupied by all storage, treatment, or disposal operations that will be used during interim status;

The name of each operation. *(Example—multiple hearth incinerator, drum storage area, etc.)*;

Areas of past storage, treatment, or disposal operations;

Areas of future storage, treatment, or disposal operations; and

The approximate dimensions of the property boundaries and all storage, treatment, and disposal areas.

Section VI

All existing facilities must include photographs that clearly delineate all existing structures; all existing areas for storing, treating, or disposing of hazardous waste; and all known sites of future storage, treatment, or disposal operations. Photographs may be color or black and white, ground-level or aerial. Indicate the date the photograph was taken on the back of each photograph.

Section VII

Enter the latitude and longitude of the facility in degrees, minutes, and seconds. For larger facilities, enter the latitude and longitude at the approximate mid-point of the facility. You may use the map you provided for Section IX of Form 1 to determine latitude and longitude. Latitude and longitude information is also available from Regional Offices of the U.S. Department of Interior, Geological Survey and from State agencies such as the Department of Natural Resources.

Section VIII

See the form for the instructions to Section VIII.

Section IX and Section X

All facility owners must sign Section IX. If the facility will be operated by someone other than the owner, then the operator must sign Section X. Federal regulations require the certification to be signed as follows:

A. For a corporation, by a principal executive officer at least the level of vice president;

B. For a partnership or sole proprietorship, by a general partner or the proprietor, respectively; or

C. For a municipality, State, Federal, or other public facility, by either a principal executive officer or ranking elected official.

FORM 3

1706-KE WASTE TREATMENT SYSTEM

SECTION B
FACILITY DESCRIPTION

This section provides a general description of the hazardous waste management facility as required by 40 CFR 270.14(b)(1) and WAC 173-303-806(4)(a)(i). This description is intended to acquaint the permit application reviewer/ permit writer with an overview of the Hanford Site and this facility. More complete details on this facility can be found in other parts of this permit application.

B-1 GENERAL DESCRIPTION

The Hanford site is a 570 square mile tract of semi-arid land which is owned and operated by the U. S. Department of Energy. This site is located northwest of the city of Richland, Washington in the Columbia Basin. The city of Richland lies approximately three miles from the southern-most portion of the Hanford Site boundary and is the nearest population center (see Figure B-1). In early 1943, the United States Army Corps of Engineers selected the Hanford Site as the location for reactor, chemical separation, and related facilities for the production and purification of plutonium. A total of eight graphite-moderated reactors using Columbia River water for once-through cooling were built along the Columbia River.

N Reactor is a new type of dual-purpose reactor used to produce both plutonium and steam for electricity. N Reactor remains in operation today. The 100-KW and 100-KE Reactors were constructed in 1952 and 1953, respectively, and operations at the reactors were terminated in 1970 and 1971, respectively.

Activities are centralized in numerically designated areas on the Hanford Site. The reactor facilities (active and decommissioned) are located along the Columbia River in what are known as the 100 Areas. The reactor fuel processing and waste management facilities are in the 200 Areas which are on a plateau about seven miles from the river. The 300 Area, located north of Richland, contains the reactor fuel manufacturing facilities and the research and development laboratories. The 400 Area, five miles northwest of the

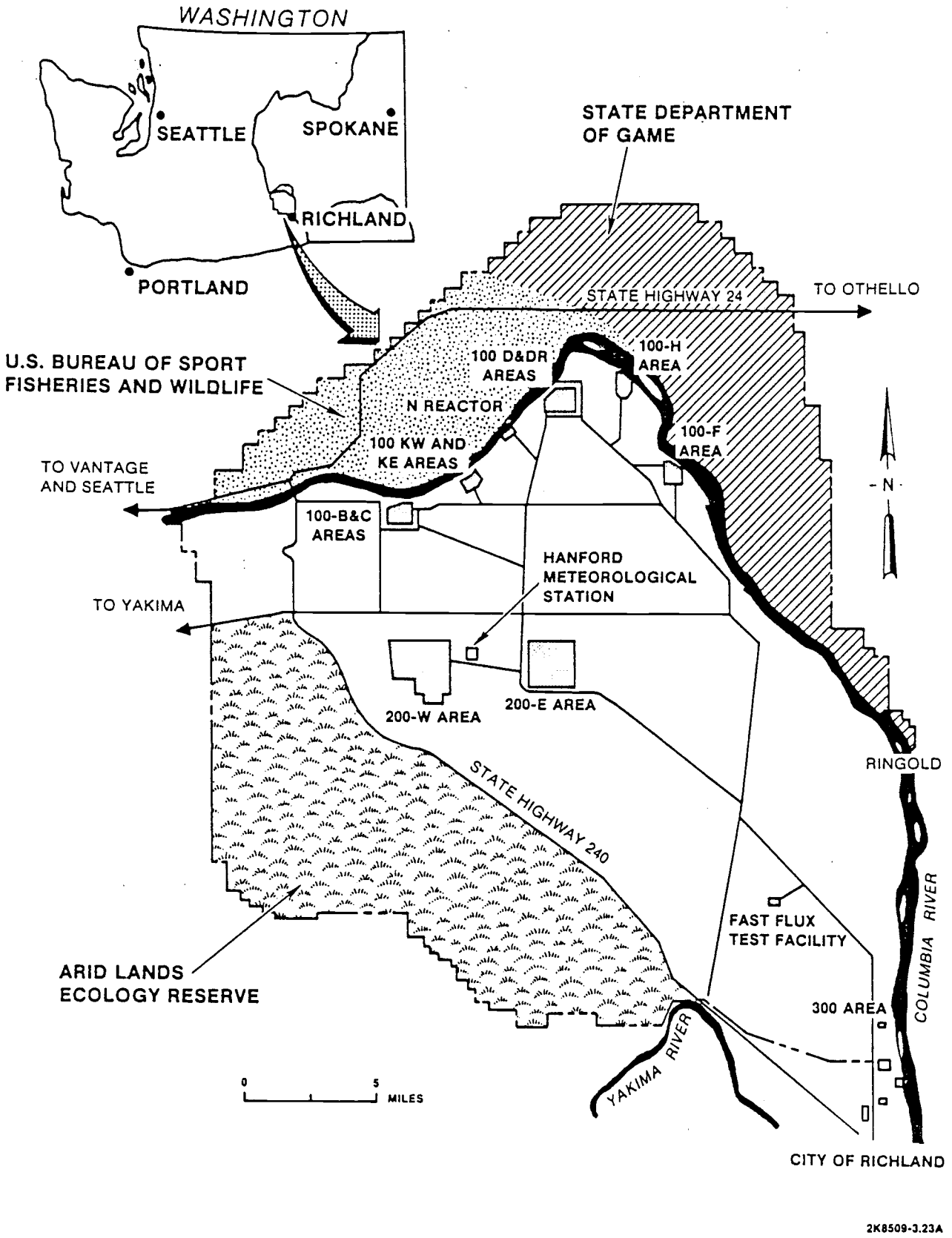


FIGURE B-1
SURROUNDING LAND USE

300 Area, contains the Fast Flux Test Facility. The 1100 Area, north of Richland, contains facilities associated with maintenance and transportation functions for the Hanford Site. Administrative buildings and other research and development laboratories are found in the 3000 Area, also north of Richland. The Nonradioactive Dangerous Waste Storage Facility is located between the 200 East and 200 West Areas on Route 3S, which is also located in the 600 Area.

The 1706-KE Waste Treatment System is a newly identified system used for chemical and physical treatment of liquid radioactive mixed wastes. A brief description of this facility follows:

1706-KE Waste Treatment System -- The 1706-KE Chemistry and Waste Treatment Technology Building is a laboratory building used for physical and chemical tests of various N Reactor systems. The laboratories in the 1706-KE Building generate radioactive mixed wastes. The 1706-KE Waste Treatment System is an onsite facility used for the storage and treatment of these wastes. The laboratory wastes are transported from a transfer station to a large accumulation tank on the -27 foot level of the building. The waste in the tank will be circulated through an ion exchange column to remove ionic waste constituents. The effluent from the ion exchange column will then be evaporated, and the condensate collected in a tank. The vapors from the evaporation process will be passed through a filter system prior to being exhausted. The liquids in the condensate collection tank will be tested for hazardous and radioactive characteristics and will be released only if nonradioactive and nonhazardous.

B-2 TOPOGRAPHIC MAPS

The map in Appendix B-1 is a general overview map of the entire Hanford Site property and the surrounding countryside. This figure is intended as a location map and illustrates the following:

- The facility boundary which for purposes of the permit application is defined as those portions of the Hanford Site located within the perimeter security fences shown on the map;

- Surrounding land use including the Saddle Mountain National Wildlife Refuge and the State Game Reserve to the north and the Rattlesnake Mountain Ecological Reserve located to the west. Land east of the Hanford Site across the Columbia River is primarily farmland or a part of the Game Reserve. The surrounding land area is also shown in Figure B-1;

- Contours sufficient to show surface water flow. Because of the area shown, contours indicate 20 foot spacing;

- Fire control facilities located on the Hanford Site;

- Locations of access roads, internal roads, railroads, and perimeter gates and barricades; and

- Longitudes and latitudes.

The map in Appendix B-2 is a topographic map of the 100-K Area of the Hanford Site. The contours on this map are 2-foot spacing.

Figure B-2 illustrates wind rose data for various locations on the Hanford Site. Winds are predominately from the west.

Figure B-3 shows the layout of the 100-K Area. The 100-K Area is surrounded by a perimeter chain link fence with one access road and a locking gate.

The location of the 1706-KE Waste Treatment System and container storage area are shown on the 1706-KE Building layout drawings shown in Figures B-4 through B-6.

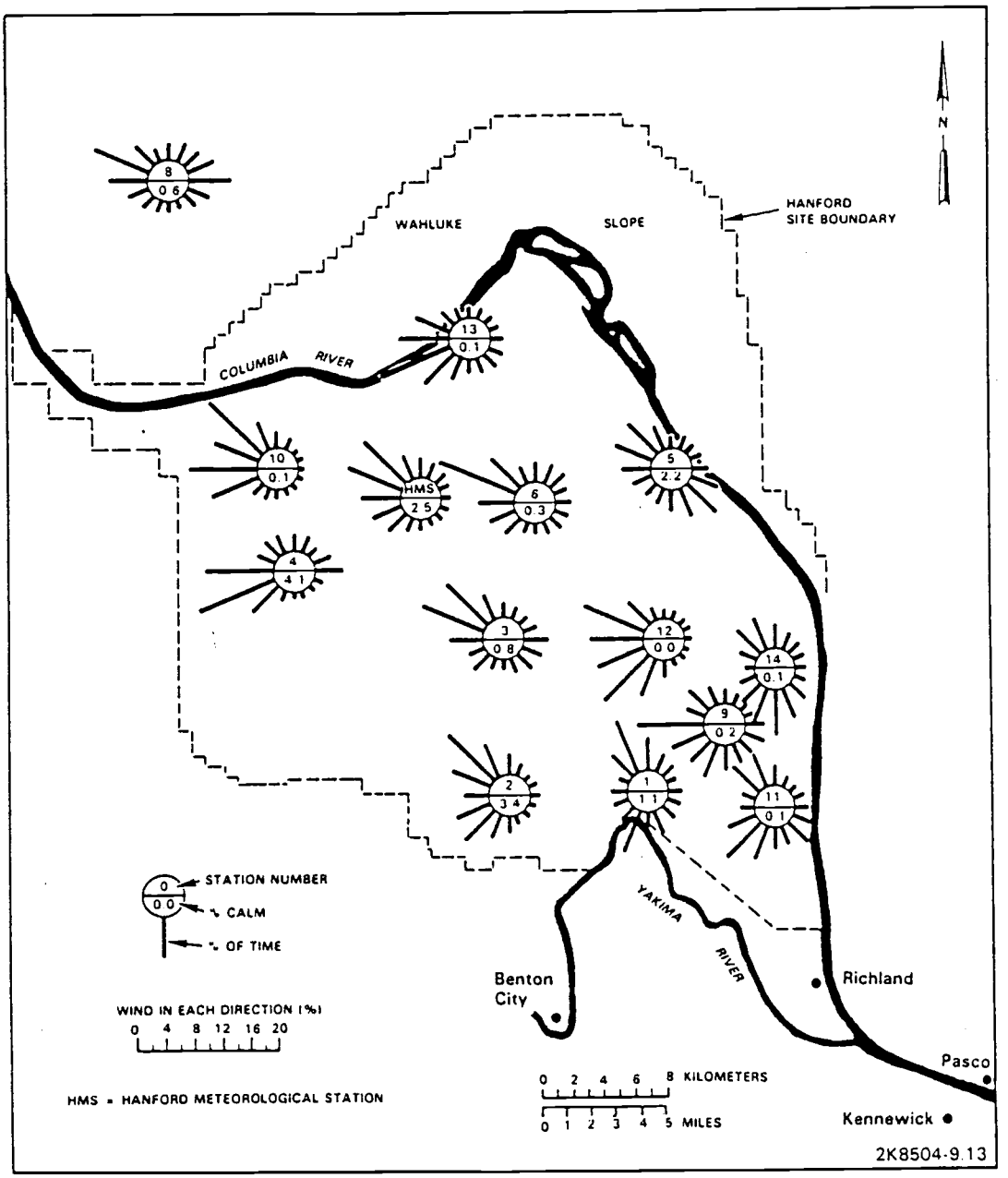


FIGURE B-2
WIND ROSE DATA FOR THE HANFORD TELEMETRY NETWORK

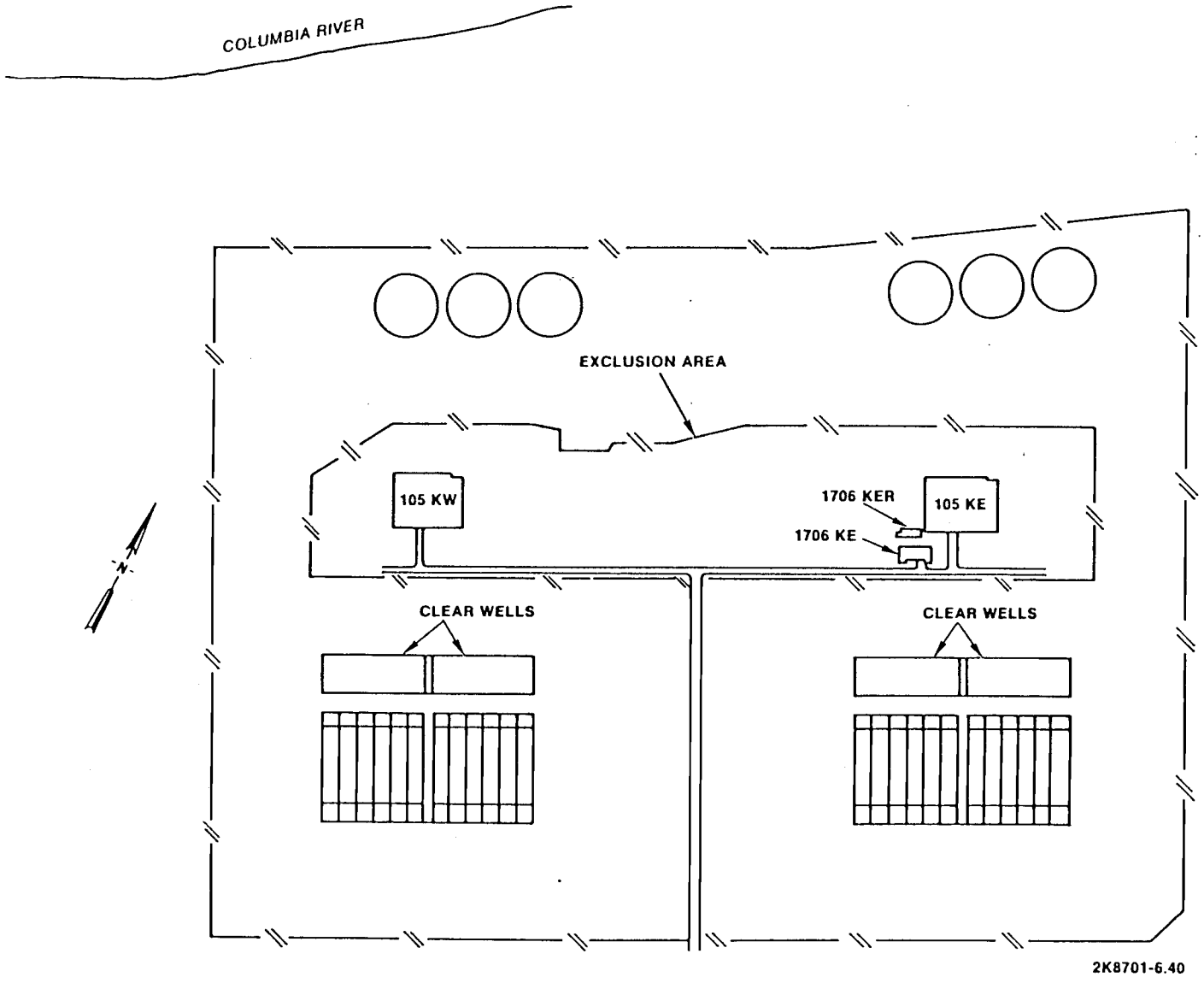


FIGURE B-3
100-K AREA LAYOUT

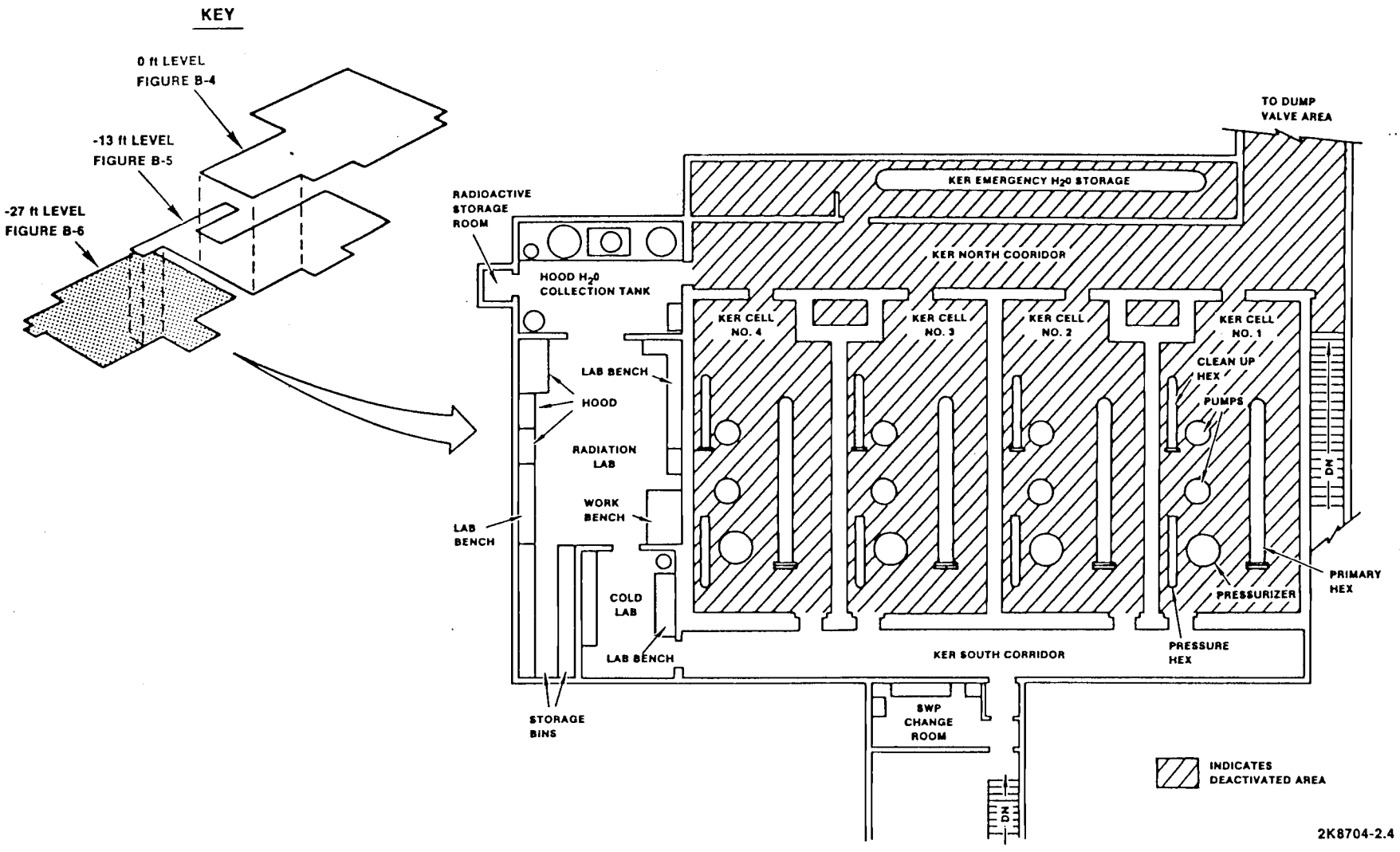


FIGURE B-6
1706-KE BUILDING, -27-FOOT LEVEL

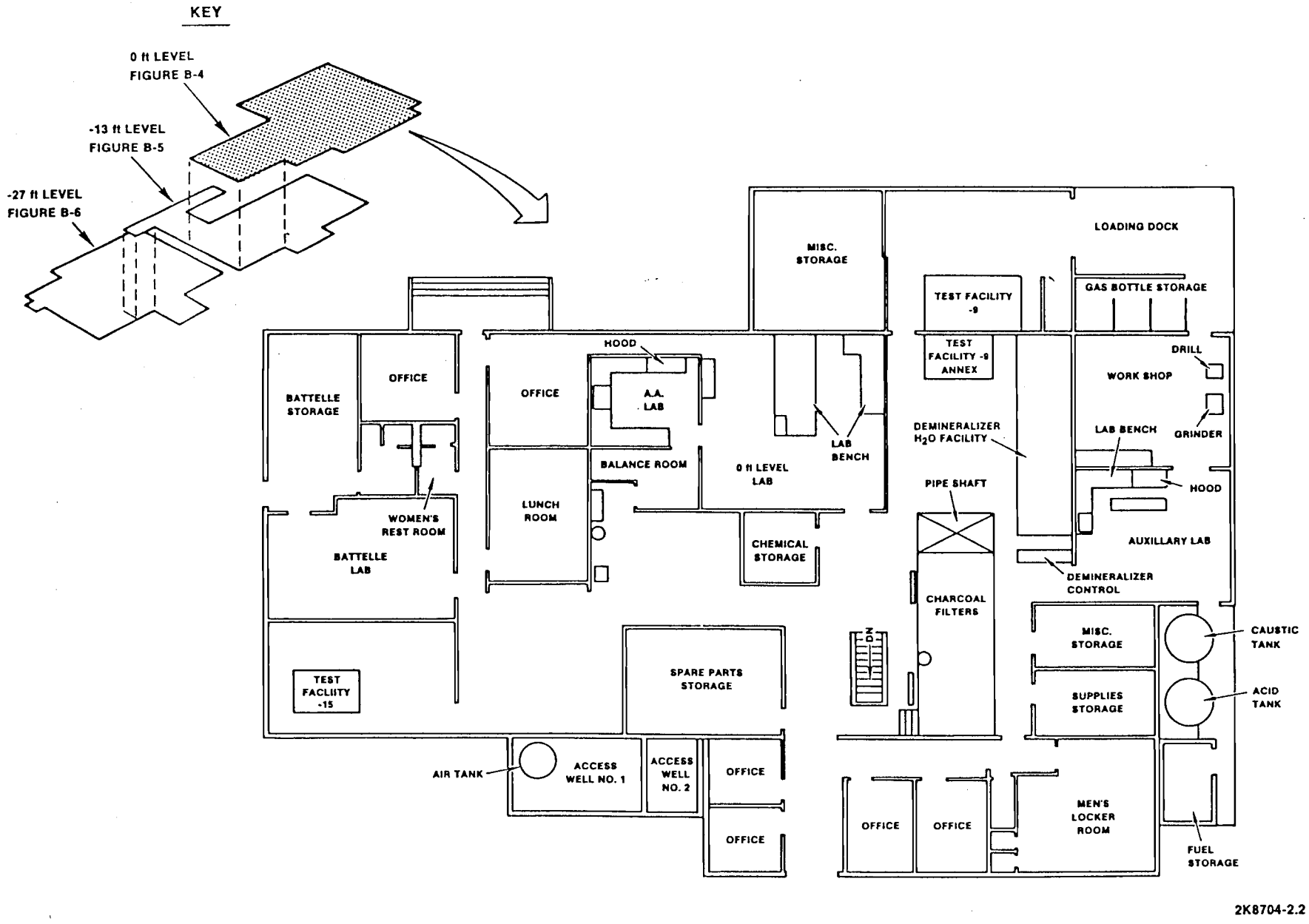


FIGURE B-4
1706-KE BUILDING, 0-FOOT LEVEL

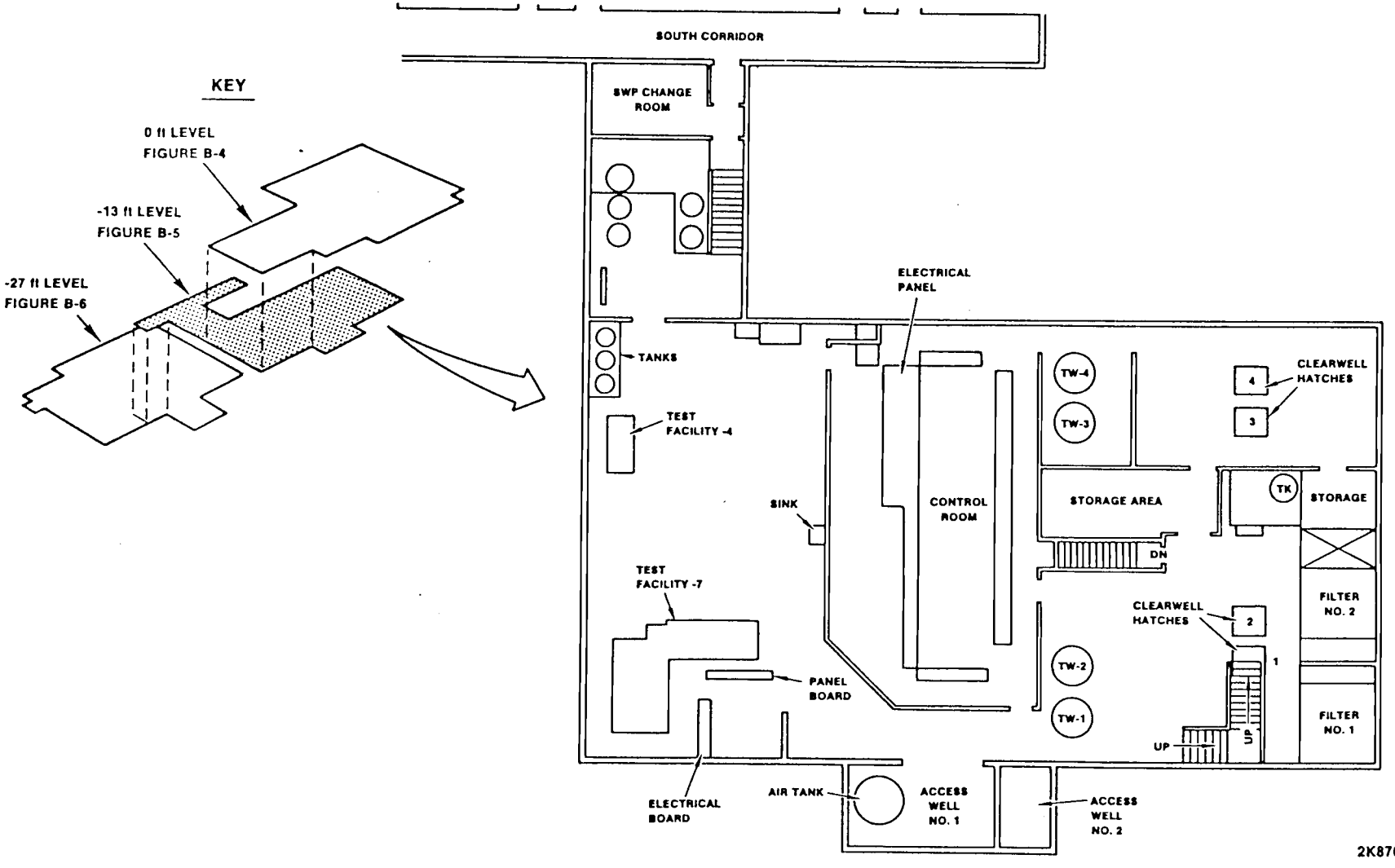


FIGURE B-5
1706-KE BUILDING, -13-FOOT LEVEL

B-3 LOCATION INFORMATION

B-3(a) Seismic Consideration

The DOE Hanford Site is not located within any of the political jurisdictions identified in Appendix VI of 40 CFR 264 or WAC 1734-303-420(3)(C) which are considered to be seismically active. Thus, further demonstration of compliance with the seismic standard of 40 CFR 264.18 and WAC 173-303-806(xi)(B) is not required.

B-3(b) Floodplain Standard

The Army Corp of Engineers (Jamison, 1982) has calculated the probable maximum flood based on the upper limit of precipitation falling on a drainage area and other hydrologic factors such as antecedent moisture conditions, snowmelt, and tributary conditions that could lead to maximum runoff. The probable maximum flood for the Columbia River below Priest Rapids Dam has been calculated to be 1.4 million cubic feet/second. The floodplain associated with the probable maximum flood is shown in Figure B-7. The inundated area shown in Figure B-7 is greater than that which would be inundated during a 100 year flood. The 1706-KE Waste Treatment System addressed in this Part B permit application is located above the 100 year floodplain.

B-3(b)(1) Demonstration of Compliance

The hazardous waste management unit under consideration in this permit application is not located within the 100 year floodplain and there is no plan for establishing a unit in the floodplain. A further demonstration of compliance is therefore not applicable for this Part B permit application.

B-4 TRAFFIC INFORMATION

The 1706-KE Waste Treatment System is located within the Hanford Controlled Access Area where roadways cannot be accessed by the general public. This facility is isolated from the nearest public highway, State Highway 24, by at least 6 miles.

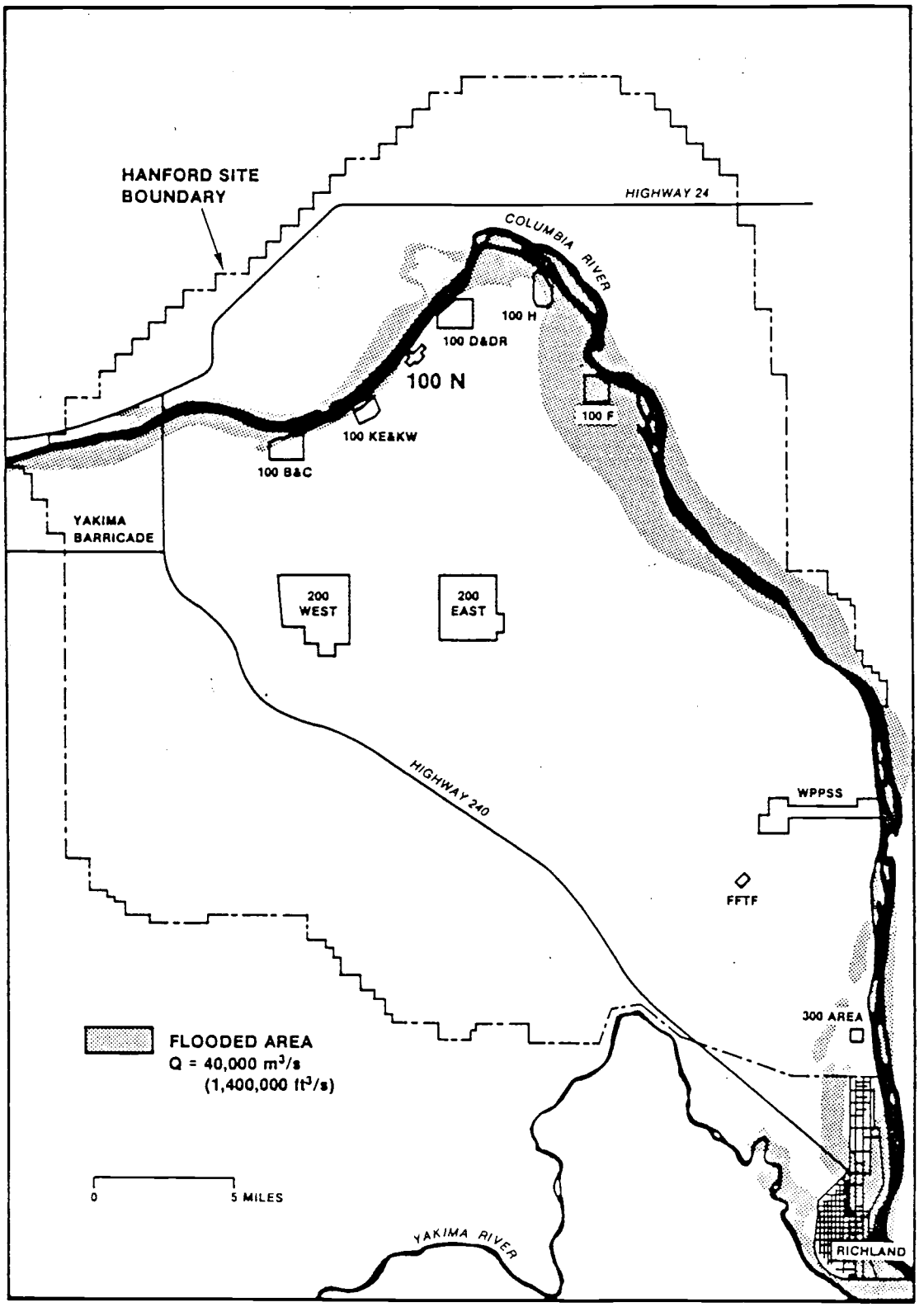


FIGURE B-7
PROBABLE MAXIMUM FLOOD AREA

Roadways inside the Hanford Site are restricted to authorized personnel and cannot be accessed by the general public. The majority of traffic inside the Hanford Site boundaries consists of light duty vehicles and buses used to transport the employees to the various operations sites located within the Hanford Site.

Figure B-8 shows the major roads throughout the Hanford Site. These roads are classified as either primary or secondary routes. The primary routes include Routes 4S, 10, 4N and the portion of 11A east of route 4N. All other roads are secondary routes. The primary routes are constructed of bituminous asphalt (usually two inches thick, but the thickness of the asphalt layer will vary with each road) with an underlying aggregate base. The secondary routes are constructed of asphalt with an underlying aggregate base. The aggregate base consists of various types and sizes of rock found on site.

The 1706-KE Waste Treatment Facility is located approximately two miles from the Hanford Site Highway which is used by site personnel traveling to the 100 Areas. The road leading to the 1706-KE Building is asphalted.

All waste is carried from the point of generation in the 1706-KE Building to the 1706-KE Waste Treatment System via polyethlene tubing. Vehicle traffic on the roads around the 1706-KE Building is light, and no waste is transported via roadways to the treatment facility. Evacuation routes are covered in Section G, Contingency Plan.

B-5 REFERENCES

Jamison, J. D., "Standardized Format for Hanford Environmental Impact Statements," PNL-3509 PT2, 1982.

WP# 9135A

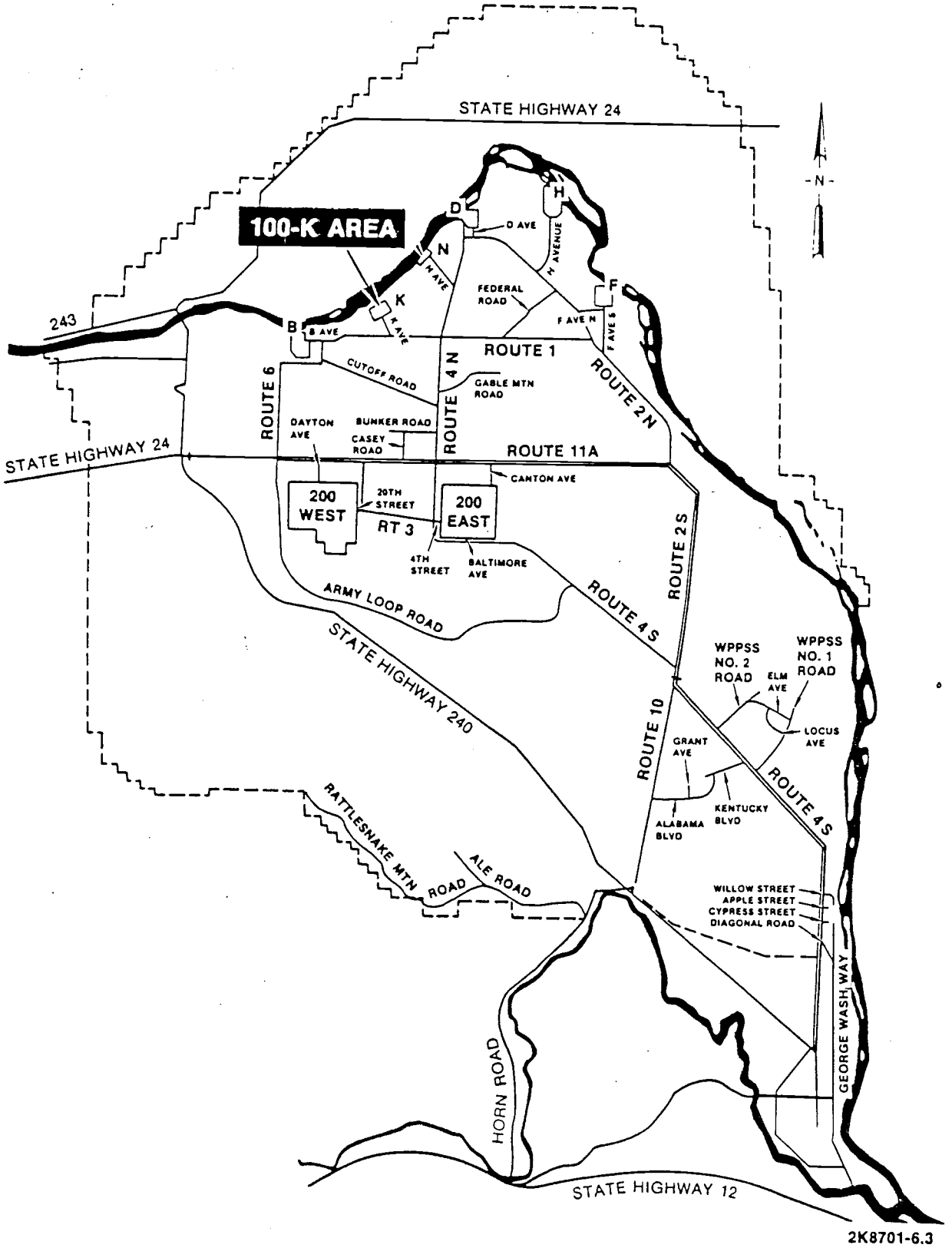


FIGURE 2-8
HANFORD SITE ROADS

SECTION C
WASTE CHARACTERISTICS

The wastes which will be treated in the 1706-KE Waste Treatment System are generated in various laboratory facilities in the 1706-KE Building. These laboratories are used to conduct chemical and physical tests of various N Reactor systems.

The laboratory wastes consist primarily of liquid radioactive and radioactive mixed wastes, and are collected at the point of generation of the wastes. The wastes collected at the point of generation will be contained in carboys or other appropriate containers in satellite accumulation areas. The carboys will be stored until they are full, and then they will be transported to the waste transfer station in the 1706-KE Building. From the waste transfer station, the wastes will be transferred by a small pump via polyethylene tubing to the waste accumulation tank of the 1706-KE Waste Treatment System.

The waste accumulation tank is a 550 gallon tank used to contain the wastes prior to treatment. All wastes placed into the accumulation tank will be neutralized to a pH of approximately 7.0 standard units shortly after admittance to the tank.

When there is a sufficient volume in the waste accumulation tank for treatment, the inlet lines to the waste accumulation tank will be closed. The wastes will be treated in a batch process mode only. The wastes will then be circulated through an ion exchange column and back to the accumulation tank. This waste will be continually recirculated through this system until the column has become saturated or the waste liquid contaminants have been reduced to an acceptable level.

The wastes will then be transferred from the accumulation tank to the evaporation unit where the liquids will be heated to approximately 100°C and boiled to steam. This steam will be condensed and collected in the condensate collection tank. The vapors from the evaporation process will be pulled

through a filter to collect the gaseous emissions and then through a High Efficiency Particulate Air (HEPA) filter system to collect any particulates prior to being discharged to the environment.

The liquid in the condensate collection tank will then be transferred to 55-gallon containers which will be stored in the container storage area until their contents have been determined to be nonhazardous and nonradioactive. The container storage area will be capable of holding up to 15 55-gallon containers. When the contents of the containers have been determined to be nonhazardous and nonradioactive, they will be released as non-designated solid wastes.

C-1 CHEMICAL AND PHYSICAL ANALYSIS

The 1706-KE waste accumulation tank currently contains approximately 400 gallons of liquid radioactive mixed wastes. The contents of this tank will be sampled and analyzed according to procedures specified in SW-846, "Test Methods for Evaluating Solid Wastes." The analyses will include pH, conductivity, reactivity, ignitability, total organic carbon, ICP analysis, and ion chromatography. These analyses will provide information necessary to properly designate the wastes currently in the accumulation tank.

Following designation of the wastes, the contents of the tank will be transferred to containers and shipped to the Hanford Site Waste Management Contractor for storage and treatment. The entire 1706-KE Waste Treatment System will be triple-rinsed with clean water following the removal of the waste in the accumulation tank. This rinsate will also be collected and transferred to the Hanford Site Waste Management Contractor. Swipe samples of the interior of the system will be taken and analyzed to ensure that all hazardous waste residues have been removed.

The chemical and physical composition of all wastes to be placed into the 1706-KE Waste Treatment System following the clean-out of the tank will be recorded on a log sheet. An example of this log sheet is included as Figure C-1. This log sheet will provide the information necessary to manage the waste in accordance with the requirements of 40 CFR 264 and WAC 173-303.

ACCUMULATION CARBOY FOR:

_____ HAZARDOUS (NON-RADIOACTIVE)

_____ ORGANIC

_____ RADIOACTIVE

DATE	ADDITION NO.	MATERIAL(S) ADDED (FOR MIXTURES, GIVE CHEMICAL CONSTITUENT %'s)	WASTE VOLUME ADDED	SIGNATURE

2K8701-6.3

FIGURE C-1
1706-KE LABORATORY WASTE DISPOSAL LOGSHEET

The wastes treated in the 1706-KE Waste Treatment System may include, but are not limited to, acids, caustics, liquid wastes containing heavy metals, organic acids, sulfates, nitrates, and chlorides. Liquid wastes which are radioactively contaminated will also be treated in the system. Based on current estimates, the system is expected to treat less than a total of 1500 gallons of waste per year.

These wastes will be treated in the 1706-KE Waste Treatment System in a batch process mode. No wastes will be added to the system after treatment begins. All of the treatment process effluent (condensate) will be transferred to containers which will be moved to the container storage area before the waste inlet lines to the waste accumulation tank are re-opened. Since the waste accumulation tank is equipped with an agitator which provides complete mixing of the tank contents, this batch process treatment mode will ensure that the treatment effluent (condensate) exhibits relatively uniform characteristics.

Duplicate composite samples will be taken of the treatment effluent while the effluent is being transferred from the condensate collection tank to the containers. There is a sample tap on the condensate collection tank drain line. Two samples will be taken consisting of a composite of approximately 500 ml from the filling of each effluent storage container. These composite samples will be representative of the entire treatment effluent.

These samples will be sent to a laboratory for analysis. The analysis will be done to provide all information necessary to verify that the treatment effluent (condensate) is not designated as a hazardous waste under 40 CFR 261 and WAC 173-303. The samples will be analyzed for the parameters listed in Table C-1.

The parameters listed in Table C-1 were selected to provide preliminary screening information on the characteristics of the treatment effluent (condensate) in order to designate the effluent. These parameters are toxicity, corrosivity, ignitability, total organic carbon, and reactivity.

In addition, if the log sheets indicate that a hazardous waste constituent has been introduced into the 1706-KE Waste Treatment System which the analyses listed in Table C-1 will not detect in the treatment system effluent, the samples will be analyzed for that additional waste constituent.

If analysis of the treatment effluent indicates either the presence of any toxic constituent at a concentration of greater than 100 ppm, or a pH of less than or equal to 2.0 or greater than or equal to 12.5 standard units, or the presence of a reactive or ignitable hazardous waste, the results of the analyses will be sent to the Hanford Site Waste Management Contractor for further waste designation.

If the 1706-KE Waste Treatment System treatment effluent is determined to be a designated hazardous waste, the containers of the effluent will be sealed and sent to the Hanford Site Waste Management Contractor for storage and further treatment.

C-2 WASTE ANALYSIS PLAN

The composition of wastes which will be treated in the 1706-KE Waste Treatment System will be recorded on a log sheet prior to admittance into the waste accumulation tank. An example of this log sheet is shown in Figure C-1. The system operator will thus be able to determine the total volume of each waste constituent in the waste accumulation tank. This will provide chemical and physical information on each waste batch treated in the 1706-KE Waste Treatment System.

The by-products of the treatment process - the contaminated ion exchange column and the sludge in the evaporation unit - will not be sampled. Instead, these solid wastes will be designated according to the log sheets kept of the wastes being placed into the accumulation tank. These log sheets will provide a conservative estimate of the types of waste materials which remain in the ion exchange column and/or the evaporation unit. Following designation of these wastes, they will be shipped to the Hanford Site Waste Management Contractor for proper dispositioning.

The effluent from the treatment process (condensate) will be sampled and analyzed to determine whether it is a hazardous and/or radioactive waste. This effluent will be sampled according to the following waste analysis plan.

C-2a Parameters and Rationale

The effluent from the treatment process will be sampled, and the samples analyzed for the hazardous waste parameters listed in Table C-1. These parameters, toxicity, pH, reactivity, total organic carbon and ignitability, were chosen to provide designation information on the anions and cations which may be present in the treatment effluent (condensate).

Radiological sampling of the treatment effluent will be done by the system operators in the 1706-KE Building.

If the chemical constituents listed on the waste influent log sheets indicate the presence of parameters not listed in Table C-1, the samples will be analyzed for those additional waste constituents. If any wastes are generated in the 1706-KE Building for which the analytical laboratory cannot provide reliable analyses, these wastes will not be treated in the 1706-KE Waste Treatment System but will be sent to the Hanford Site Waste Management Contractor for treatment. The system operating procedure will include restrictions on the type of wastes to be treated.

C-2b Test Methods

The effluent condensate from the 1706-KE Waste Treatment System will be sampled and the samples will be analyzed for the parameters listed in Table C-1. The test methods for these analyses are also listed in Table C-1.

If the chemical constituents listed on the waste influent log sheet indicate the presence of parameters other not listed in Table C-1, the samples will be analyzed for these additional parameters. These additional tests will be conducted using EPA approved methods.

TABLE C-1

1706-KE EFFLUENT ANALYSIS

Characteristics	Parameters	Test Method
	Metals	
1. Toxicity	Zinc Calcium Barium Cadmium Chromium Silver Sodium Nickel Copper Vanadium Aluminum Manganese Potassium Iron Magnesium Beryllium Osmium Strontium Antimony	SW-846, #6010
	Ions	
	Nitrate Sulfate Fluoride Chloride Phosphate	Ion Chromatography
2. pH	pH	SW-846, #9040
3. Reactivity		
4. Ignitability		
5. Total Organic Carbon		SM-505

C-2c Sampling Methods

Duplicate composite samples will be taken of the treatment system effluent (condensate) in the condensate collection tank to determine whether the effluent is a hazardous waste. These samples will be taken in accordance with the procedures specified in SW-846, Test Methods for Evaluating Solid Waste, Section One, "Sampling of Solid Wastes."

The composite samples will be taken while the treatment effluent (condensate) in the condensate collection tank is being transferred into 55-gallon containers. The samples will be taken via a sample line located on the tank drain line. This sample line is shown on Figure C-1.

The samples will be collected and preserved in accordance with the requirements of the analytical laboratory to which the samples will be sent.

C-2d Frequency of Analyses

Two composite samples will be taken for analyses from each batch of waste which is treated in the 1706-KE Waste Treatment System.

C-2e Additional Requirements for Wastes Generated Offsite

This section is not applicable as the 1706-KE Waste Treatment System is not used to treat any wastes other than those generated in the 1706-KE Building.

C-2f Additional Requirements for Ignitable, Reactive, or Incompatible Wastes

The 1706-KE Waste Treatment System is not used to treat any ignitable wastes. Procedures will be written to prevent the introduction of ignitable wastes into the treatment system.

The 1706-KE Waste Treatment System is not used to treat any reactive hazardous wastes. Personnel who are involved with operating the system will be familiar with the physical and chemical properties of the compounds that they are dealing with, and will not introduce any materials into the system which may cause an adverse chemical reaction in the system.

A copy of the 40 CFR 264 Appendix V Table of "Examples of Potentially Incompatible Wastes" is kept near each logbook for materials to be added to the 1706-KE Waste Treatment System. Operations personnel will refer to this table before adding any new wastes to the system to avoid adding incompatible wastes. The facility specific hazardous waste training program for the operators of the 1706-KE Waste Treatment System will provide information and training on potentially incompatible wastes to those operators.

C-3 WASTE MINIMIZATION

The 1706-KE Waste Treatment System is used to treat radioactive mixed wastes generated in the laboratories in the 1706-KE Building.

The activities in the laboratories which generate radioactive mixed wastes shall be reviewed to identify potential waste minimization steps. These steps may include:

- Segregating wastes into four categories, nonhazardous, hazardous, radioactive, and radioactive mixed wastes. Nonhazardous and strictly hazardous wastes will not be introduced into the system;

- Limiting the volume of reagents used to the amount necessary and not more; and

- substituting nonhazardous reagents for hazardous reagents, wherever possible.

These steps will minimize the volume of wastes which are introduced into the 1706-KE Waste Treatment System.

The treatment will produce solid radioactive mixed wastes as by-products. The first will be the resins in the ion exchange column. As these resins remove contaminants from the waste stream, the resins will become saturated. When the resins no longer function effectively, they will be properly disposed of as a radioactive mixed waste.

The waste container in the evaporation unit will also contain a small volume of solid radioactive mixed waste in a sludge form. If the unit fails to function effectively due to sludge buildup, the container will be removed, sealed and disposed of as a radioactive mixed waste. The carbon and HEPA filters will also be disposed of as radioactive mixed wastes when they do not function efficiently due to saturation or plugging of the filters.

The 1706-KE Waste Treatment System is an effective volume reduction process. The system treats a volume of liquid radioactive mixed waste and produces a smaller volume of solid radioactive mixed wastes and nonhazardous liquids.

SECTION D
PROCESS INFORMATION REQUIREMENTS

The 1706-KE Waste Treatment System is a waste treatment system consisting of an accumulation tank to store radioactive mixed wastes, an ion exchange column, an evaporation unit, a condensate tank to collect the treatment effluent, and a container storage area. These facilities are used to treat radioactive mixed wastes which are generated in the 1706-KE Building.

The 1706-KE Building contains several laboratories and test facilities which are used to conduct chemical and physical tests of various systems and components used at N-Reactor. The locations of these facilities are shown on Figures B-4 through B-6. These tests generate: 1) nonradioactive nonhazardous wastes, 2) nonradioactive, hazardous wastes, 3) radioactive mixed wastes, and 4) radioactive wastes. The 1706-KE Waste Treatment System is used to treat the radioactive mixed wastes and the radioactive wastes.

The 1706-KE facilities are used by the Chemistry & Waste Treatment Technology (C&WTT) department of N-Reactor's Development and Technology group as a laboratory and testing unit.

The components of the 1706-KE Waste Treatment System have been in place on the -27 foot level of the 1706-KE Building since January, 1987. The container storage area design is currently being developed. This waste treatment system replaces a series of systems used by the C&WTT unit which did not provide hazardous waste treatment in accordance with WAC 173-303 and 40 CFR 264. This system will not be operated until all system components meet the regulatory requirements of WAC 173-303 and 40 CFR 264 and an operating procedure has been written for the system.

All of the wastes from the 1706-KE Building laboratories are collected at the point of generation in satellite accumulation containers in accordance with WAC 173-303-200. The composition of all wastes is recorded on a log sheet as shown in Figure C-1 before the waste is placed in the containers.

When a radioactive mixed waste or radioactive waste container is full, the container will be transported to a transfer pumping station near Test Facility 4 (TF4). From this location a small pump will be used to transfer the wastes via polyethylene tubing to the waste accumulation tank of the 1706-KE Waste Treatment System, located one floor below the transfer station.

The liquid radioactive mixed wastes will be collected in the waste accumulation tank until either the tank is full, or the waste has been stored in the tank for one year, whichever comes first. The waste in the tank will then be treated in a batch process. All accumulated waste will be treated before more waste is added to the tank. The interior of the waste accumulation tank will be rinsed with clean water, and the rinsate treated in the system, before the waste inlet lines to the tank are re-opened.

Prior to beginning treatment of the waste, all waste inlet lines to the tank will be valved closed. The waste will then be circulated through the ion exchange column and back to the waste accumulation tank. This waste will be continuously circulated through the ion exchange column and back to the waste accumulation tank until the ion exchange column becomes either (1) saturated with contaminants to the point of ineffectiveness, (2) radioactive to the prescribed limits, or (3) the waste is reduced to nonhazardous and nonradioactive concentrations.

A measure of the conductivity of the waste effluent from the ion exchange column will be used as an indicator of the effectiveness of the ion exchange column. If the effluent has a conductivity of less than twice the conductivity of demineralized water, this will be an indication that the hazardous constituents have been removed from the waste.

The waste will be collected in 55-gallon containers and stored in the container storage area until samples of the waste taken and analyzed in accordance with the waste analysis plan described in Section C determine the waste to be nonradioactive and nonhazardous. If the samples indicate that the waste is still hazardous and/or radioactive, it will be placed back in the system and treated in the evaporation unit.

If the wastes require additional processing they will be fed from the waste accumulation tank into the evaporation unit. The evaporation unit includes a DOT 17H specification 30-gallon container encased within a heater unit. The wastes in the container will be heated until all the liquid wastes have been vaporized into steam.

This steam will be passed through a condenser and air exhaust system where any airborne volatile hazardous and radioactive constituents will be entrapped in carbon and HEPA filters. The liquid wastes from the condenser will flow through a one-inch stainless steel tubing line into a 96 gallon stainless steel collection tank. From the collection tank the wastes will be transferred to 55-gallon containers. These containers will be stored in a container storage area in the 1706-KE Building.

Samples will be taken while filling each of the containers. Two composite samples will then be made and sent to a laboratory for analysis. If they are shown to be nonradioactive and nonhazardous, the contents of the containers will be released as a non-regulated solid waste. If the contents of the containers cannot be released, the containers will be sealed and transported to the 200 Areas of the Hanford Site for storage and/or further treatment in accordance with all applicable requirements.

The contaminated ion exchange column will be packaged and shipped to the Hanford Site Waste Management Contractor for disposal as a radioactive mixed waste. The container used in the evaporation unit may contain radioactive mixed waste in a solid form. When the container becomes too full of sludge to operate efficiently in the evaporation unit, the container will be removed, sealed and shipped to the Hanford Site Waste Management Contractor for proper disposal.

Because the volume of exhaust air from the evaporation unit is expected to be small, the carbon and HEPA filters will not require frequent replacement. Personnel from the Hanford Environmental Health Foundation (HEHF) conduct periodic inspections of the filter systems. These personnel will indicate

when the filters need to be replaced. When they do need replacement, the carbon and HEPA filters will be removed and contained for disposal as radioactive mixed wastes.

The 1706-KE Waste Treatment System is contained completely on the -27 foot level of the 1706-KE Building. All wastes to be treated in the system are generated in the 1706-KE Building.

The waste accumulation tank, the ion exchange column, the evaporation unit, and the associated piping are set within a secondary containment curb. The condensate tank and its piping are set within another secondary containment curb.

The container storage area will also be located on the -27 foot level of the 1706-KE Building, down the hall from the 1706-KE Waste Treatment System. The containers will be stored on top of plastic stands which will be set in an aluminum pan. The aluminum pan will serve as a secondary containment device.

The exhaust air will be transported through the filter system via a stainless steel six-inch tube from the condenser unit. A charcoal filter is housed in a vertical canister just downstream of the condensate collection tank. Air exhausted from the system will first pass through this canister, followed by passage through the HEPA filter system.

The air exhaust system is comprised of a stainless steel containment with a charcoal filter to collect any hazardous vapors followed by a HEPA filter system designed to entrap any particulates. Exhausted air is pulled via an exhaust fan located downstream of the filters. The exhausted air is discharged to the atmosphere via a small stack. A continuous radiation monitor monitors the discharged air for signs of radioactive breakthrough of the HEPA filter system.

The 1706-KE Waste Treatment System is used to treat a volume of liquid radioactive and radioactive mixed waste. The effluent from the treatment system will be a non-regulated solid waste. By-products of the treatment process will include contaminated ion exchange column resins, filters, and a sludge in the evaporation unit container.

D-1 CONTAINERS

Radioactive and radioactive mixed wastes are stored in small containers prior to their addition to the 1706-KE Waste Treatment System. These containers are used for the accumulation of up to 55 gallons of radioactive mixed waste and radioactive wastes. The containers are stored in a satellite accumulation area which meets the requirements of WAC 173-303-200, at or near the point of generation of the wastes. The requirements for a satellite accumulation area are described in the memorandum in Appendix D-1.

The effluent (condensate) from the 1706-KE waste treatment process will also be stored in containers. The waste in the condensate collection tank will be collected in 55-gallon DOT 17H specification containers. These containers will be transferred to the container storage area in the 1706-KE Building for storage until their contents have been declared nonhazardous and nonradioactive and can be properly disposed of as non-regulated wastes.

The container storage area will be located on the same level as the 1706-KE Waste Treatment System, in a room adjacent to the waste treatment system. The containers will be placed on plastic stands which set in an aluminum pan. The aluminum pan will constitute the secondary containment for the containers as required by WAC 173-303-630(7).

D-1a Containment System

The containment system for the containers holding effluent from the 1706-KE Waste Treatment System will consist of an aluminum pan made of a welded sheet of aluminum. The pan will be set on the concrete floor and will be of sufficient volume to contain either the volume of the largest container in the

pan, or ten-percent of the combined volume of all the containers in the pan, whichever is greater. The container storage area secondary containment system will be designed to meet the requirements of WAC 173-303-630(7)(a) & (b).

D-1a(1) Design Parameters

The proposed design of the secondary containment is shown in Figure D-1. The secondary containment device will be a long rectangular pan made of a sheet of aluminum metal with welded corners.

The aluminum pan will be designed to hold up to ten 55-gallon containers. The containers will sit on top of plastic stands. The pan will be placed against the wall on a concrete floor.

D-1a(2) Drainage System

The containers will be placed on plastic stands which are set on the bottom of the pan. These plastic stands will allow any potential leakage to drain away from the bottom of the containers. The plastic stands will be high enough so that the volume of the largest leak (1 container volume) in the pan will not come into contact with the other containers.

D-1a(3) Capacity

The secondary containment for the container storage area will be large enough to hold up to 10 containers. The secondary containment system will be large enough to contain ten percent of the combined volume of all of the 10 containers, or at least 55 gallons without the leaked waste coming into contact with any of the containers.

D-1a(4) Run-On Control

This section is not applicable. The container storage area will be located completely within the 1706-KE Building and will not come into contact with any form of precipitation.

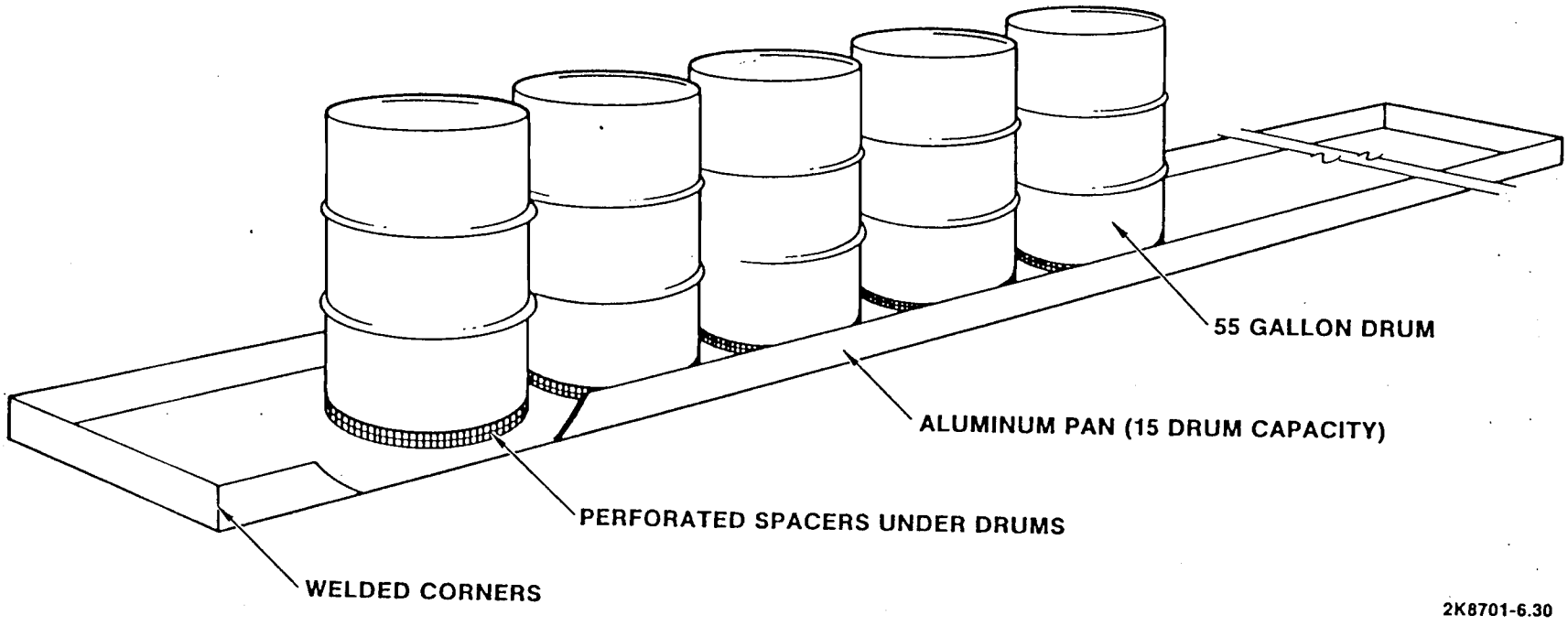


FIGURE D-1
CONTAINER STORAGE AREA

D-1a(5) Removal of Accumulated Liquids

The secondary containment system for the container storage area will be slightly sloped. Therefore, if a leak should occur from one of the containers the liquid would drain away from the container and toward one corner of the pan. No containers will be stored in this corner of the pan. The accumulated liquids could then be removed with the use of a portable pump and/or absorbent pads.

D-1b Containers Storing Hazardous Wastes That Do Not Contain Free Liquids

This section is not applicable. All of the containers which will be stored in the container storage area of the 1706-KE Building will contain free liquids.

D-1c Procedures For Managing Ignitable, Reactive, or Incompatible Wastes

No ignitable or reactive wastes are treated in the 1706-KE Waste Treatment System. Therefore, the effluent from the system, which is stored in the container storage area, will not contain ignitable or reactive wastes.

Procedural controls will be instituted to ensure that no potentially incompatible wastes will be treated in the waste treatment system. The hazardous waste training program for the 1706-KE Waste Treatment System will provide instruction to system operators concerning the limits and controls on the types of waste which may be added to the system, and will provide examples of potentially incompatible wastes. Therefore, the containers containing the treatment effluent will not contain incompatible materials.

D-2 TANKS

Two tanks are used in the 1706-KE Waste Treatment System. The first tank is a 550 gallon stainless steel tank with a wall thickness of 1/4-inch used for accumulation of the wastes generated in the 1706-KE Building. This tank is used to store the wastes until a sufficient quantity of wastes are available

for treatment. Procedural controls will be instituted to ensure that if the tank is not full after one year of accumulation, the wastes in the tank will be treated by the end of that year.

The second tank is a condensate collection tank. This is a 96 gallon tank which is used to collect the liquid condensate from the evaporation process of the 1706-KE Waste Treatment System. More information on this tank is provided in Appendix D-2. The wastes in the tank will be transferred to 55-gallon containers which will then be transferred to the container storage area.

The design and process information in this section was written to comply with the requirements of 40 CFR 264, Subpart J, and WAC 173-303-640. The new tank regulations, promulgated July 14, 1986, had not been adopted by the State of Washington at the time of this permit application.

D-2a Assessment of Tank Integrity

The specific Part B information requirements for tank systems in 40 CFR 270.16(a) require a written assessment that is reviewed and certified by an independent, qualified, registered professional engineer to the integrity and suitability for handling hazardous waste of each tank system as required under 5264.191.

The tanks used in the 1706-KE Waste Treatment System meet the definition of existing tank systems under the new tank regulations of July 14, 1986. 40 CFR 264.19(a) states that an assessment of an existing tank system's integrity must only be done for those tank systems which do not have secondary containment that meets the regulatory requirements by January 12, 1988.

The waste accumulation tank and the condensate collection tank of the 1706-KE Waste Treatment System are scheduled to have secondary containment which meets the regulatory requirements by January 12, 1988. Therefore, no assessment of the integrity and suitability of these tanks is required.

If for some reason these tanks do not have acceptable secondary containment in place by January 12, 1988, then the required assessment of the tank system's integrity will be performed.

D-2b Design Parameters

Waste Accumulation Tank

The 1706-KE Waste Accumulation Tank is a 550 gallon tank used to contain the wastes from the 1706-KE Building prior to their treatment. This tank is 4.6 feet high, with a diameter of 4.5 feet. The tank is fabricated of 1/4-inch 304 stainless steel.

The basis for selecting the shell thickness of the 1706-KE waste accumulation tank will be described in a statement written in accordance with WAC 173-303-640(2)(a). This statement will be submitted to the Hanford Site Engineering and Construction Contractor for certification by a professional engineer. The certified statement will then be submitted to the Washington Department of Ecology (WDOE) for review and approval of the tank design.

There is one waste inlet line to the accumulation tank. This line is made of 5/8-inch polyethylene tubing. More information on this tubing is provided in Appendix D-3. The contents of the tank are mixed by the use of an agitator which is mounted on the top of the tank.

The wastes in the tank are transferred to the ion exchange column by a positive displacement pump. The wastes are pumped through 1/2-inch stainless steel tubing attached to the bottom of the tank by a welded pipe connector. The wastes are pumped from the bottom of the tank to the top, and are then pumped to the ion exchange column. The wastes are pumped through the ion exchange unit, and exit the unit near the bottom. The processed waste solution is then re-circulated back into the waste tank via an inlet at the top of the tank. Figure D-2 shows the design, piping, and instrumentation of the waste accumulation tank, and Figure D-3 shows the process flow for the system.

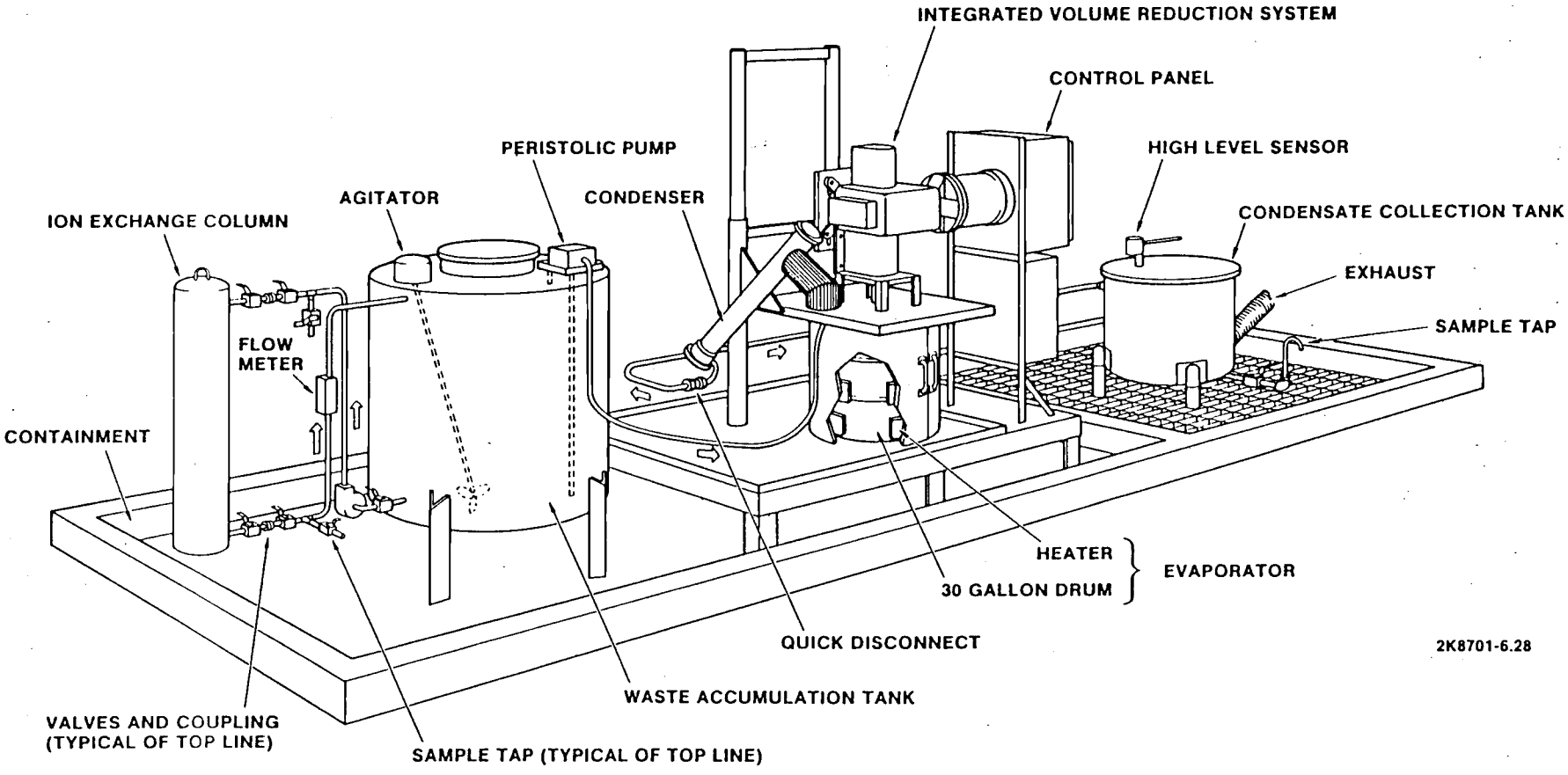


FIGURE D-2
1706-KE WASTE TREATMENT SYSTEM DESIGN

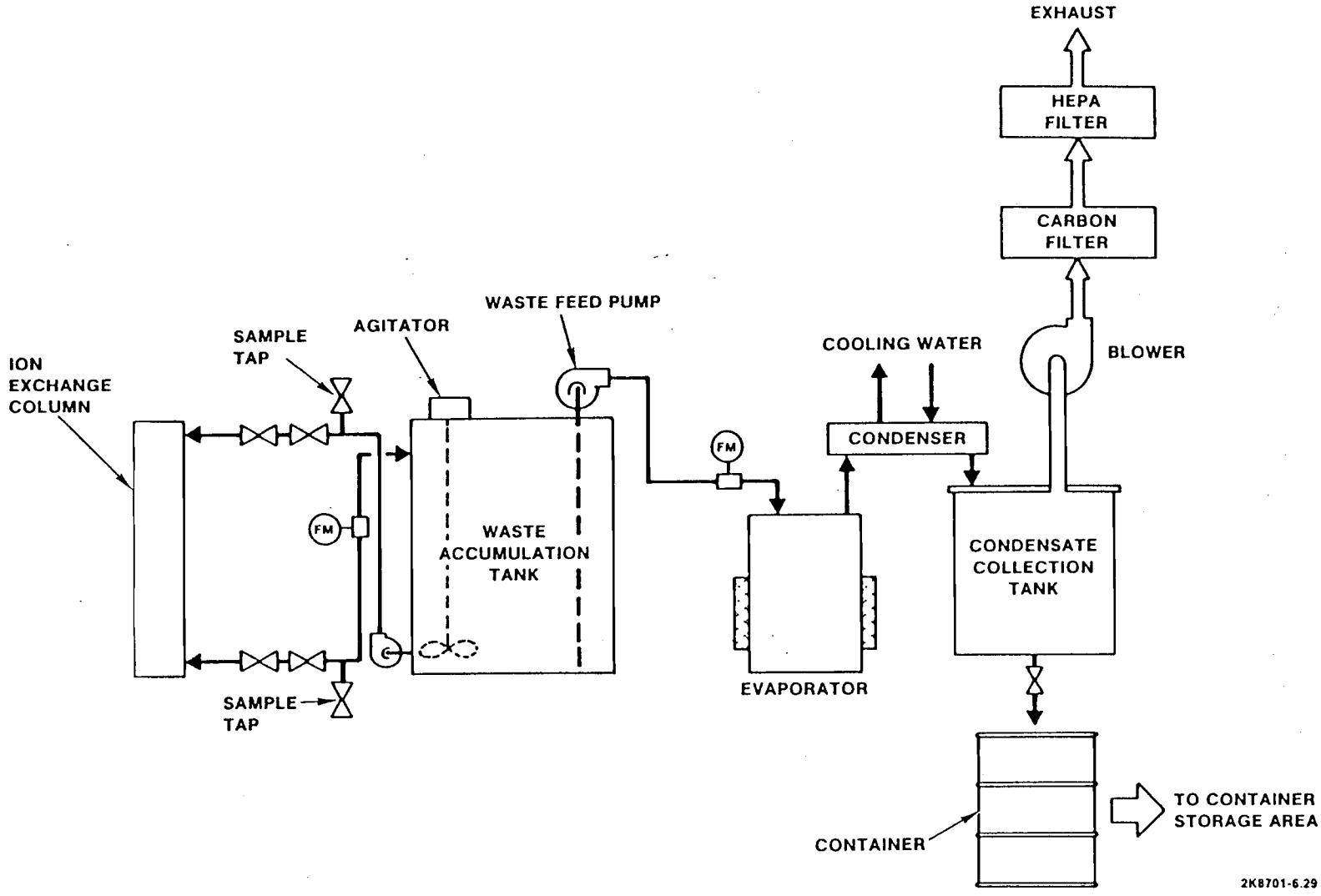


FIGURE D-3
1706-KE WASTE TREATMENT SYSTEM
PROCESS FLOW DIAGRAM

Condensate Tank

The condensate collection tank is a 96-gallon 304 stainless steel tank used to collect the liquid effluent from the evaporation unit of the 1706-KE Waste Treatment System. The condensate tank is 3.25 feet high, with a diameter of 2.7 feet. The tank is fabricated from 304 stainless steel. More information on the condensate tank is provided in Appendix D-2.

The basis for selecting the shell thickness of the 1706-KE condensate collection tank will be described in a statement written in accordance with WAC 173-303-640(2)(a). This statement will be submitted to the Hanford Site Engineering and Construction Contractor for certification by a professional engineer. The certified statement will then be submitted to the Washington Department of Ecology (WDOE) for review and approval of the tank design.

The vapors from the evaporation process are condensed and then flow into the condensate collection tank via 1-inch stainless steel tubing. The inlet to the tank is located near the top of the tank.

The vapors from the evaporation process are pulled through a plastic exhaust pipe by a blower. The exhaust is passed through first a carbon filter and then through a HEPA filter system before being released through an exhaust stack.

The liquids in the condensate collection tank are removed from the tank via a transfer line located near the bottom of the tank. There is also a sample line attached to this transfer line. The condensate will be pumped from the condensate collection tank to 55 gallon storage containers.

Figure D-2 shows the design and piping of the condensate collection tank. Figure D-3 shows the process flow diagram for this tank.

D-2c Control Systems

Waste Accumulation Tank

The waste accumulation tank of the 1706-KE Waste Treatment System will be equipped with a level sensor device. This level sensor will be mounted approximately 12-inches from the top of the tank, and will sound an alarm if the wastes in the tank reach this level.

The accumulation tank is also equipped with an agitator. This agitator is used to provide mixing of the contents of the tank. The agitator is a 1725 RPM Neptune 1/4 horsepower motor with a 46-inch shaft and a 3-bladed propeller.

Waste feed to the accumulation tank will be controlled from the waste feed station in the TF4 Laboratory. The system operator will physically check the level of wastes in the accumulation tank prior to adding more wastes at the transfer station. The operator will ensure that the additional wastes will not overfill the waste accumulation tank. The pump at the waste feed station will be shut off whenever the tank high level alarm sounds indicating the tank is full. The waste feed from the tank to the ion exchange column is controlled by a positive displacement pump. This pump can be manually shut off to stop the feed of wastes from the tank. There are two valves located on the outlet of the tank which can be used to control the re-circulating flow of wastes.

Waste flow from the accumulation tank to the evaporation unit is controlled by a peristolic pump and a rotometer. More information on this waste feed pump is provided in Appendix D-4. More information on the rotometer, including calibration curves, is provided in Appendix D-5. This rotometer will be calibrated each time the 1706-KE Waste Treatment System is used. No wastes will be pumped from the accumulation tank to the evaporator until the wastes have first been re-circulated through the ion exchange column.

Condensate Collection Tank

Condensed vapors drain into the condensate collection tank from the evaporation unit via a stainless steel tubing line. The liquids in the condensate tank will be transferred from the tank via a line near the bottom of the tank. This line is isolated until the contents of the tank is ready to be transferred into storage containers.

A liquid high level alarm in the condensate collection tank will be used to ensure that the level of the contents does not overfill the tank. More information on this level sensor is provided in Appendix D-6.

D-2d Corrosion Protection

D-2d(1) External Corrosion Protection

This section is not applicable. The two tanks being described in this permit application are located within a completely enclosed building. Therefore, none of the components of either tank will be in contact with the soil or water. Both tanks are set on coated concrete surfaces. These tanks are not required to have external corrosion protection.

D-2d(2) Internal Corrosion Protection

No wastes which are incompatible with the materials of construction of the waste accumulation tank or the condensate collection tank will be placed in those tanks. During the hazardous waste training for the operators of the 1706-KE Waste treatment System, the operators will be given guidance concerning types of wastes which are potentially incompatible with the tank interiors. All wastes placed into the waste accumulation tank will be neutralized to a pH of approximately 7.0 standard units. The interior of the waste accumulation tank will be inspected yearly to check for signs of corrosion.

D-2e Secondary Containment System

Waste Accumulation Tank

The 1706-KE Waste Accumulation Tank will be provided with a secondary containment system which meets the requirements of 40 CFR 264.193. The secondary containment for this tank consists of a concrete curb.

This secondary containment system will be coated with a sealant material which will protect the concrete curb from the waste materials stored in the tank. A guidance document published by the Portland Cement Association (PCA), included as Appendix D-7, will be used to select the most appropriate coating material.

The secondary containment system was designed to contain the entire volume of the 550-gallon waste accumulation tank. This system was built with a slight slope to facilitate removal of any wastes released from the tank. Figure D-2 shows the design of the secondary containment system for the waste accumulation tank.

The secondary containment system is located within a completely enclosed building. Therefore, the containment system was not designed to prevent run-on or infiltration of precipitation, and does not have an external moisture barrier to prevent migration of moisture into the secondary containment system.

All ancillary equipment for the waste accumulation tank will be provided with secondary containment. The valves, pumps, and waste outlet lines of the tank are located within the tank's secondary containment system.

The waste inlet piping consists of 5/8-inch polyethylene tubing. This tubing will be enclosed within larger polyethylene tubing to provide secondary containment for the waste inlet line. More information on this tubing is provided in Appendix D-3.

The leak detection system for the waste accumulation tanks and associated ancillary piping will consist of visual inspections conducted daily for releases into the secondary containment system of the tank and the waste inlet piping. This inspection will be conducted by the Building Manager of the 1706-KE Building or his designated alternate according to procedures described in Section F of this application. This inspection is designed to detect the failure of either the primary of secondary containment structure or the presence of any release of hazardous waste of accumulated liquid in the secondary containment system within 24 hours. Inspection logs will be used to document the inspections and any observations made.

Condensate Collection Tank

The 1706-KE Condensate Collection Tank will be provided with a secondary containment system which meets the requirements of 40 CFR 264.193. The secondary containment for the condensate collection tank consists of a concrete curb.

This secondary containment system will be coated with a sealant material which will protect the concrete berm from the waste materials stored in the condensate tank. A guidance document published by the Portland Cement Association (PCA), included as Appendix D-7, will be used to select the most appropriate coating material.

The secondary containment system was designed to contain the entire volume of the 96-gallon condensate collection tank. This vault was built with a slight slope to facilitate removal of any wastes which may be released from the tank. Figure D-2 shows the design of the secondary containment system for the condensate collection tank.

The secondary containment system for the condensate collection tank is located within a completely enclosed building. Therefore, no precipitation or run-on will be allowed to infiltrate the vault, nor will the vault be in contact with external moisture. Thus, no controls were designed to prevent contact of the secondary containment system with liquids from external sources.

All of the ancillary equipment of the condensate collection tank will be provided with secondary containment. The valves, pumps and waste inlet and outlet piping are located within either the secondary containment for the condensate tank or the secondary containment for the waste accumulation tank.

The leak detection system for the waste accumulation tank and associated ancillary equipment will consist of visual inspections conducted daily for releases into the secondary containment systems of the tank and ancillary equipment. These inspections will be conducted by the building manager of the 1706-KE Building or his designated alternate according to procedures described in Section F of this application. This leak detection inspection is designed to detect the failure of either the primary or secondary containment structure or the release of any hazardous wastes or accumulated liquids in the secondary containment system within 24 hours. Inspection logs will be used to record the inspections and any observations made during the inspections.

D-2f Spill Control

Appropriate controls and practices will be used in operating the 1706-KE Waste Treatment System to prevent overflows from the tank systems or the secondary containment systems. Spill prevention controls include the level sensors in both the waste accumulation tank and the condensate collection tank. These sensors will sound an alarm when the wastes in the tank reach the level of the sensor. This will help prevent spills due to overfilling of the tanks.

The 1706-KE Waste Accumulation Tank is always kept closed except when it is necessary to remove the lid to provide maintenance to the system. The 1706-KE Condensate Collection Tank is also kept closed except during maintenance. Procedural controls will be instituted which will require that the tank contents be drained into 55-gallon containers every time the tank is filled.

The secondary containment systems are designed with a slight slope so that any released wastes will drain to one side of the containment vault. If the daily

visual inspections detect the presence of liquids in the secondary containment vault, these liquids will be removed within 24 hours using a portable pump and/or sorbent pads.

If a leak or spill should occur from either tank system, the requirements of 40 CFR 264.196 concerning response to leaks or spills will be complied with. The waste inlet lines to the 1706-KE Waste Treatment System will be closed, and the unit will be removed from service. Any leaked or spilled wastes will be removed from the secondary containment system within 24-hours, and all visible releases to the environment will be removed and properly disposed of.

Any release to the environment from the 1706-KE Waste Treatment System will be reported to the EPA and WDOE within 24 hours. A report containing the release monitoring data and describing any response actions taken will be submitted within 30 days of the release.

If the release is found to be due to a leak from any component of the tank system, repairs will be made to the tank system as necessary before the tank is used again. If any major repair activities, as defined by 40 CFR 264.196(f) are conducted, these repairs will be certified by a registered professional engineer.

D-2g Procedures for Managing Ignitable, Reactive, or Incompatible Wastes

The 1706-KE Waste Treatment System is not designed to treat ignitable or reactive wastes. Procedural controls will be instituted to prevent the introduction of ignitable or reactive wastes into the system.

The personnel in the 1706-KE Building have been provided with copies of the 40 CFR 264 Appendix V, "Examples of Potentially Incompatible Wastes," list. This list will be referred to prior to the addition of any new waste to the waste accumulation tank. In addition, the hazardous waste training, as described in Section H of this application, will provide the system operators with information concerning the types of wastes which may be placed into the 1706-KE Waste Treatment System. Therefore, the 1706-KE Waste Treatment System will not be used to manage incompatible wastes.

D-3 WASTE PILES

This section is not applicable as DOE-RL does not manage hazardous wastes in waste piles at the 1706-KE Waste Treatment System.

D-4 SURFACE IMPOUNDMENTS

This section is not applicable as DOE-RL does not manage any hazardous wastes in surface impoundments at the 1706-KE Waste Treatment System.

D-5 INCINERATORS

This section is not applicable as DOE-RL does not manage any hazardous wastes using incinerators at the 1706-KE Waste Treatment System.

D-6 LANDFILLS

This section is not applicable as DOE-RL does not manage any hazardous wastes in landfills at the 1706-KE Waste Treatment System.

D-7 LAND TREATMENT

This section is not applicable as DOE-RL does not manage any hazardous wastes in land treatment units at the 1706-KE Waste Treatment System.

D-8 CHEMICAL, PHYSICAL, AND BIOLOGICAL TREATMENT UNITS

It is understood that no final facility standards have been promulgated by either the U.S. Environmental Protection Agency (EPA) or the Washington Department of Ecology (WDOE) for chemical, physical, and biological treatment units. However, two of the units in the 1706-KE Waste Treatment System can best be described as physical or chemical treatment units. Therefore, this section will describe how the 1706-KE Waste Treatment System will be designed and operated to meet the interim status standards of 40 CFR 265, Subpart Q, for Chemical, Physical, and Biological Treatment.

D-8a Operating Information

The process flow diagram for the 1706-KE Waste Treatment System is shown in Figure D-3. The waste materials from the 1706-KE Waste Accumulation Tank are fed into the top of the ion exchange column. The waste stream flows through the ion exchange column, where the resins remove anions and cations from the waste. The waste stream exits the ion exchange column near the bottom, and will be routed back to the waste accumulation tank via Tygon tubing.

This waste will be re-circulated from the accumulation tank to the ion exchange column. When the ion exchange column is saturated, the waste stream will be transferred back to the waste accumulation tank. The valves to the ion exchange column will be closed, and the unit will be removed from service.

The liquids in the waste accumulation tank will then be transferred to the evaporation unit. The evaporation unit consists of a 30 gallon DOT specification container with a heating unit which closes around the container.

The wastes in the evaporation container are heated until the liquid portion of the wastes is flashed into steam. This steam is condensed in the condenser located adjacent to the evaporation unit and is collected in the condensate collection tank.

The vapor portion of the steam is collected in an exhaust system. This exhaust is filtered through first a carbon filter and then a HEPA filter. The nonhazardous, nonradioactive exhaust is then released to a stack.

The solid portion of the wastes in the evaporation unit will remain in the 30 gallon container. When the container is too full of solid materials for the evaporation unit to function effectively (about half-full), the container will be removed from the unit and replaced. The used container will be removed, sealed and shipped to the Hanford Site Waste Contractor for proper disposal as a radioactive mixed waste.

The spent ion exchange column will be removed and shipped to the waste management contractor for proper disposal. A new resin column will then be placed into the system.

None of the wastes which will be treated in either the ion exchange column or the evaporation unit will cause the equipment to rupture, leak, corrode, or otherwise fail before the end of its intended life. The log sheets being used at the points of generation of the wastes will provide an analysis of the characteristics of the overall waste stream.

Both the ion exchange column and the ion exchange unit will be provided with a means to cut off the flow of the wastes into the treatment unit. These waste influent cut-offs will be manually operated valves. More information on these valves is provided in Appendix D-8.

The 1706-KE Waste Treatment will be inspected each working day according to procedures prescribed in Section F of this application. The ion exchange column and the evaporation unit will be inspected to detect corrosion, leakage, or disrepair of the units. The monitoring and safety systems associated with these units will also be inspected each working day.

D-8b Design Information

D-8b(1) Ion Exchange Column

The ion exchange column of the 1706-KE Waste Treatment System is a 5 cubic foot column containing mixed-bed resin. The ion exchange column is approximately 5 feet high, with a diameter of approximately 1 foot. The waste inlet and outlet lines to the ion exchange column are 1/2-inch stainless steel tubing. There are screens on the inlet and outlet of the ion exchange unit to prevent the resin from leaving the unit. More information on the ion exchange column is provided in Appendix D-9.

D-8b(2) Evaporation Unit

The evaporation unit of the 1706-KE Waste Treatment System was provided by Pacific Nuclear Systems, Inc. Documentation on specific components of this system is provided in the Appendices of this section.

The evaporation unit consists of a 30-gallon DOT 17H specification container with wrap-around heaters. The heaters are mica insulated band heaters. More information on these heaters is provided in Appendix D-10. The heater is used to heat the liquid wastes to approximately 100°C. The vapors are collected from the container, and transferred to the condenser.

The evaporation unit is also equipped with a pressure sensor. More information on this pressure sensor is included in Appendix D-11.

Input from various control devices on the evaporation unit and condenser of the 1706-KE Waste Treatment System is registered on the system control panel. A drawing of this panel is shown in Figure D-4. More information on this control panel is given in Appendix D-12.

D-8b(3) Condensor

The condenser used in the 1706-KE Waste Treatment System is a Young Heat Exchanger. This unit was also provided by Pacific Nuclear Systems, Inc.

The condenser unit is a Young Fixed Tube Bundle Heat Exchanger. More information is provided on the condenser in Appendix D-13.

D-8b(4) Exhaust System

Exhaust air from the condenser will be pulled through the exhaust system with a blower. The air will be pulled through a 6-inch stainless steel tube to a charcoal filter. This filter is housed in a vertical canister located downstream of the condensate collection tank. This filter will be used to collect any gaseous pollutants.

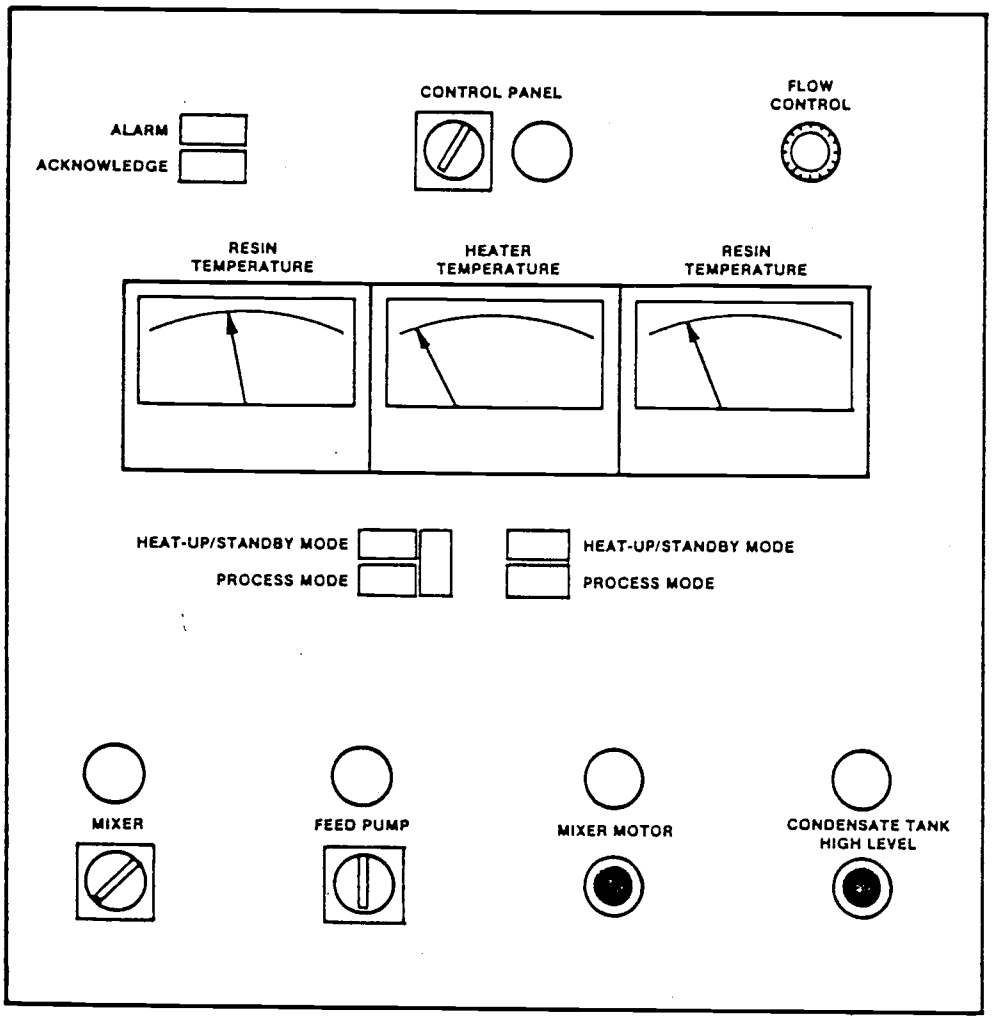


FIGURE D-4
EVAPORATION UNIT CONTROL PANEL

The exhaust from the carbon filter is then pulled through a HEPA filter system to remove the particulates. A demister is located in the exhaust system just upstream of the HEPA filters. More information on the HEPA filters and the demister is provided in Appendices D-14 and D-15, respectively.

The exhausted air is then discharged to the atmosphere via a small stack. A continuous radiation monitor monitors the discharge air for radioactive breakthrough of the HEPA filter system.

D-8c Procedures for Managing Ignitable, Reactive, or Incompatible Wastes

No ignitable or reactive wastes will be treated in the 1706-KE Waste Treatment System. Procedural controls will be instituted to prevent the addition of ignitable or reactive wastes to the waste accumulation tank.

Personnel in the 1706-KE Building have been provided with the 40 CFR 264, Appendix V, list of "Examples of Potentially Incompatible Wastes." Before adding any new wastes to the waste accumulation tank, this list will be consulted to prevent the addition of incompatible wastes to the tank. Before adding any wastes to the system which have not previously been added to the system, the operators will obtain the approval of the 1706-KE Building manager. In addition, during the hazardous waste training session for the operators of the 1706-KE Waste Treatment System the operators will be given more specific information concerning the limits and controls on the types of wastes which may be placed into the system. This training is described in Section H of this permit application.

APPENDIX D-1

SATELLITE ACCUMULATION AREA REQUIREMENTS

Requirements for Waste Accumulation in Satellite Storage Areas

1. Definition.

A satellite accumulation area is an area that is at or near the point of waste generation and under the control of the organization generating the waste.

2. Waste accumulation records.

A log must be maintained for each discharge into the individual containers within the satellite accumulation area. The log must provide the following information:

a. Date of each addition to a container.
b. Description of the composition and concentration of each waste added to a container (e.g., 10% HNO_3 and 90% H_2O). Trade names may be used.
c. Volume of each waste added to a container.
d. Signature or initials of the person making each waste addition.

3. General container requirements.

The accumulation containers must be:

a. Compatible with the waste to be added.
b. In good condition (e.g., free from severe rusting or obvious structural defects).

4. General operating requirements.

a. Satellite accumulation containers must be stored in properly identified areas. This identification shall consist of a sign which reads as follows: "Satellite Accumulation Area-Containers stored in this area must comply with the requirements of WAC 173-303-200. For more information, contact the Environmental Protection group."
b. Containers must be kept closed except when adding or removing waste. (Vent clips may be necessary for containers holding volatile materials.)
c. If a container begins to leak, the waste must be immediately transferred to a container that is in good condition.
d. Any leakage must be reported as soon as possible to the Environmental Safety section.

5. Accumulation limits.

Waste may be accumulated in a satellite area until:

a. The total volume of waste in the area exceeds 55 gallons or,
b. 90 days from the first addition of waste into a container if the total volume does not exceed 55 gallons before that time.

(Note: For accumulation of materials deemed "acutely hazardous," the maximum accumulation allowed is one quart.)

6. Labelling.

Each container in the accumulation area which holds a hazardous material must be identified as "Dangerous Waste" or "Hazardous Waste." The label must also identify the major risk(s) associated with the waste (toxic, ignitable, reactive, corrosive, or oxidizer). If a waste exhibiting a different risk is added later, the drum label should be revised accordingly or a new label should be provided.

Within UNC, the yellow waste accumulation label is used on waste containers. Unfortunately, the label is often incorrectly marked when designating the "type of waste" and the associated "major risk". In order to help correct this situation, Ms. L.A. Garner of the Environmental Protection organization will provide a review of the waste accumulation logs on a monthly basis. Ms. Garner will then determine the correct label marking. Hopefully, after a few months of waste review, lists will be developed identifying the correct marking for specific wastes.

When labelling a drum in a satellite accumulation area, the date should not be written on the label until the accumulation limit (either 90 days or 55 gallons) is reached. (For non-satellite areas, the container should be dated immediately upon generation of the waste.)

7. Container removal.

Within 3 days after exceeding the accumulation limit, the date must be written on the container label and the waste must be transferred into a 90 day container storage area. The waste must be transported to a permitted facility within 90 days after this transfer takes place.

8. Inspections.

Once each week, the containers in the satellite area must be inspected for leakage and deterioration. This inspection must be documented in a record which includes the following information:

a. The date of the inspection.
b. The name and signature of the inspector.
c. Observations of any leaks or container deterioration.
d. Corrective actions taken (if any).

A standard form has been developed to document the required inspection. This form is available from the Environmental Protection group.

A copy of the each weekly inspection record is to be sent to Ms. L.A. Garner (1145N/100N).

9. Special requirements for ignitable or reactive wastes.

Ignitable or reactive wastes must be stored in accordance with the Uniform Fire Code (UFC). If there are no specific requirements in the UFC or in state or local codes, the "Flammable and Combustible Liquids Code" is to be used. Records of an annual inspection for compliance with the applicable codes must be maintained.

Questions regarding specific fire code requirements should be addressed to the Occupational Safety section. Ms. Garner will assist in determining whether or not a waste is considered ignitable or reactive.

10. Special requirements for incompatible wastes.

Rules regarding incompatible wastes are as follows:

a. Incompatible wastes must not be placed in the same accumulation container unless special precautions are taken to insure such mixing can be done safely.
b. Waste must not be placed in a container which previously held an incompatible material unless the container has been cleaned.
c. Accumulation containers holding incompatible wastes must be kept separated by means of a dike, berm, wall, or other device.

If there are any questions as to whether or not specific wastes are incompatible, appropriate personnel must be consulted before mixing or commingling.

APPENDIX D-2

CONDENSATE COLLECTION TANK DESIGN

ECONOMY STAINLESS STEEL TANK

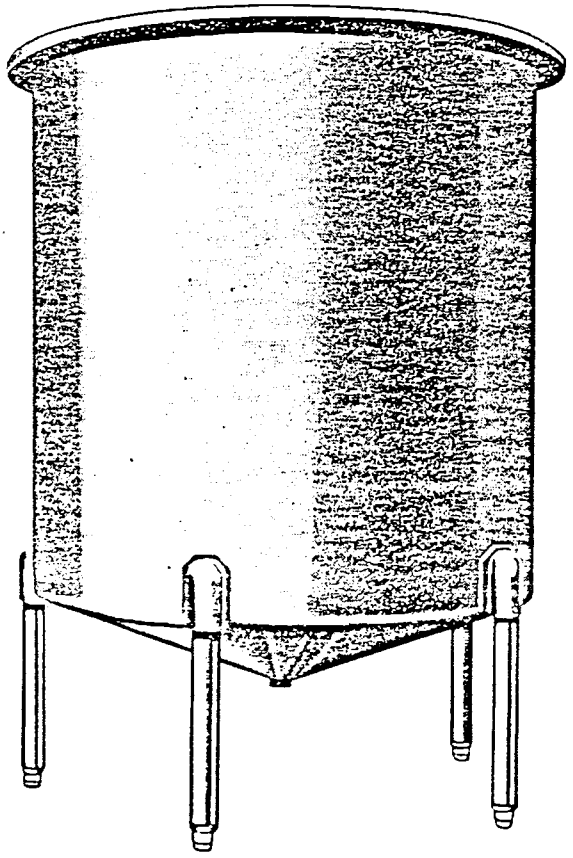
Series EVT

STANDARD FEATURES

Type 304 stainless steel with 2B mill finish.
15° cone bottom (with drain fitting included in price).
Sanitary radius corners. All welds planished, passivated & leak tested.
Stainless steel mixer pad.
2" pipe legs in stainless steel hip sockets. (Beam legs on tanks over 3,000 gal.)
Heavy gauge construction.
STOCKED FOR QUICK DELIVERY:
18- 1,000 gallon sizes

SPECIFICATIONS

Material of construction:	Type 304 stainless steel.
Capacity:	18 to 5,000 gal.
Finish:	2B mill finish. All internal welds ground flush & buffed to 80 grit; emery & wire-brushed exterior welds.
Diameter:	18" to 111"
Depth:	18" to 120"
Approx. net weight:	see chart on p. 11
Legs:	2" carbon steel pipe with corrosion-resistant coating & adjustable bullet feet. 6" steel beam legs on EVT-3500 thru EVT-5000. See chart on p. 11 for number of legs on tank.
Outlet:	Female threaded half coupling. See chart p. 11 for size. Allowance is made for 12" clearance from drain fitting to floor.

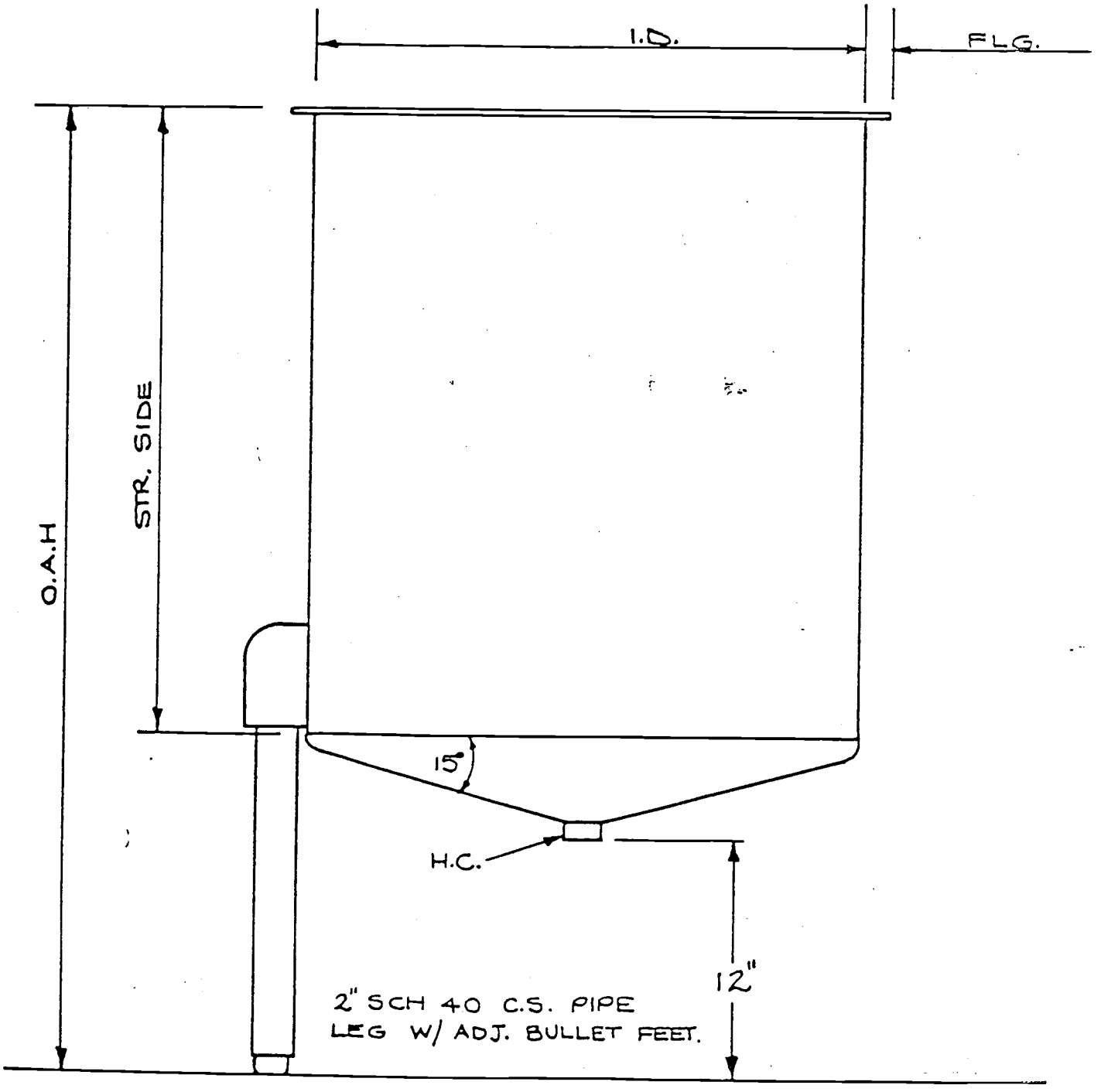


OPTIONS

(allow for additional delivery time)
Tanks are available in T-316 stainless steel at extra cost. Also available: extra fittings; 1, 2 & 3-pc. covers in stainless steel & poly; mixer bracket & channels; slot in cover for mixer; liquid level gauge & sight glass; casters; push bars; closed head with manway; fiberglass insulation with stainless steel shroud; baffles; stainless steel legs; stainless steel and carbon steel floor flanges; baffles; thru-floor brackets; electric clamp-on heaters with thermostatic control. (For covers, fittings & accessories, see p. 36-40.)

VERTICAL TANKS

W/15° CONE BOTTOM



Series VT & Series EVT

Model #	U.S. Gal.	ID	Str. Side	Cone Depth	OAH	Ga. Side	Ga. Bottom	Drain† Size	# Legs	Width Top Flange	Approx. Wt.
18	19	18"	17"	2⅜"	33"	16	16	¾"	3	1"	45
30	32	18"	29"	2⅜"	45"	16	16	1"	3	1"	50
38	42	22¾"	23"	3"	40"	16	16	1"	3	1"	57
55	63	22¾"	35"	3"	52"	16	16	1"	3	1"	70
80	96	30½"	29"	4 1/16"	47"	16	16	1"	3	1"	85
100	115	30½"	35"	4 1/16"	53"	16	16	1"	3	1"	105
125	134	30½"	41"	4 1/16"	59"	16	16	1"	3	1"	115
150	180	38"	34¾"	5 1/16"	54"	16	16	1"	3	1¼"	125
200	232	38"	46¾"	5 1/16"	66"	16	16	1¼"	3	1¼"	160
260	286	45"	40½"	6"	61"	16	16	1½"	3	1½"	175
300	327	45"	46½"	6"	67"	16	16	1½"	3	1½"	194
400	425	52"	46½"	6 15/16"	68"	16	16	1½"	4	1½"	242
480	500	56"	46½"	7½"	69"	16	16	1½"	4	1½"	252
500	550	52"	58½"	6 15/16"	79"	16	16	1½"	4	1½"	284
575	625	56"	58½"	7½"	80"	16	16	1½"	4	1½"	307
700	750	56"	70½"	7½"	92"	14	14	1½"	4	1½"	430
800	850	60"	70"	8⅜"	93"	14	14	1½"	4	1½"	455
1000	1152	69"	70"	9 3/16"	93"	14	12	2"	5	2"	735
1500	1683	83"	70"	11⅛"	95"	14	12	2"	5	2"	926
2000	2058	83"	84"	11⅛"	108"	14	12	2"	6	2"	1028
2500	2622	83"	108"	11⅛"	132"	14	12	2"	6	2"	1232
3000	3149	96"	96"	12⅞"	122"	14	12	3"	6	2"	1435
3500	3903	96"	120"	12⅞"	146"	12	12	3"	6*	2"	1650
4000	4416	102"	120"	13 11/16"	147"	12	10	3"	6*	2"	1816
5000	5246	111"	120"	17⅞"	148"	12	10	3"	6*	2"	2012

*6" beam legs
†Standard on EVT Tanks only.

APPENDIX D-3

POLYETHYLENE TUBING SPECIFICATIONS

High-quality tubing for all your fluid

Tygon® (R 3603) plastic tubing is a soft, flexible clear tubing that slips over tubulatures easily, grips tightly and bends readily to sharp-radius curves to speed and simplify set-ups. Provides long life because it doesn't oxidize. Temp range: +10° to 180°F (−12° to +82°C). Discount: *Per 100 feet of one size, less 20%.*

Vinyl tubing is tough, flexible. Polyvinyl tubing has excellent clarity, is odorless and non-toxic. Good water, chemical and abrasion resistance. Dimensional stability. Temp range: −49° to +180°F (−45° to +82°C). Discount: *100 to 249 feet, less 15%; 250 to 450 feet, less 20% (in 50-ft lengths).*

Silicone tubing is odorless, translucent. Features low compression set, good resilience, moderate solvent resistance, excellent heat resistance, good release characteristics. Temp range: −80° to +500°F (−62° to +260°C). Do not use with most concentrated solvents, oils, acids and dilute sodium hydroxide. Discount: *50-ft lengths, less 10%*

Polyethylene tubing is white, flexible, translucent. Unaffected by many chemicals. Excellent electrical insulator. Low water-vapor permeability, high O_2 and CO_2 permeability. Flexible at low temperatures. Max temp: +176°F (+80°C). Discount: *250 feet or more, less 20%.*

Polypropylene tubing is clear and more rigid than polyethylene tubing. Exceptional flex life. High chemical, stress and puncture resistance. Max temp: +275°F (+135°C). Discount: *100 feet or more, less 20%.*

Gum rubber tubing is seamless, tack free. Latex tubing can be repeatedly sterilized. Temp range: −22° to +302°F (−30° to +150°C). Discount: *250 feet or more, less 20%.*

Bev-a-line IV tubing meets FDA, USDA, National Formulary and USP standards for high purity systems. Saves up to 50% over TFE tubing. Temp range: −60° to +160°F (−51° to +71°C). Needs no connector fittings: heat and stretch tubing, cut at narrow point, mate ends, reheat for permanent bond. Sterilize with ethylene oxide. Unaffected by prolonged alcohol contact. Discount: *Per 100 feet or more of one size, less 10%.*

Dimensions (in.)			Tygon		Vinyl		Silicone		Polyethylene		Polypropylene	
ID	OD	Wall	Cat. no.	Price/ 50 ft	Cat. no.	Price/ 50 ft	Cat. no.	Price/ 10 ft	Cat. no.	Price/ 50 ft	Cat. no.	Pri 50
1/50	1/12	1/32	—	—	—	—	K-6411-59	$ 5.50	—	—	—	—
1/32	1/16	1/64	—	—	—	—	—	—	—	—	—	—
1/32	3/32	1/32	K-6408-60	$ 3.50	—	—	K-6411-60	6.50	—	—	—	—
1/16	1/8	1/32	K-6408-62	6.50	K-6405-01	$ 3.50	K-6411-62	7.08	—	—	—	—
1/16	3/16	1/16	K-6408-46	12.00	—	—	—	—	—	—	—	—
3/32	1/8	1/64	—	—	—	—	—	—	—	—	K-6400-16	$ 2
3/32	5/32	1/32	K-6408-63	7.50	—	—	K-6411-63	6.50	—	—	—	—
1/8	3/16	1/32	K-6408-64	7.00	—	—	K-6411-64	7.50	—	—	—	—
1/8	1/4	1/16	K-6408-47	20.00	K-6405-02	4.50	K-6411-67	9.60	K-6407-02	$ 3.50	K-6400-28	3
1/8	3/8	1/8	K-6408-71	48.50	—	—	K-6411-68	14.00	—	—	—	—
9/64	3/16	1/40	—	—	—	—	—	—	—	—	K-6400-25	4
5/32	7/32	1/32	K-6408-65	9.00	—	—	K-6411-65	12.50	—	—	—	—
5/32	1/4	3/64	—	—	—	—	—	—	—	—	—	—
3/16	1/4	1/32	K-6408-66	11.50	—	—	K-6411-66	11.50	—	—	K-6400-31	6
3/16	5/16	1/16	K-6408-03	32.00	K-6405-03	5.50	K-6411-03	12.50	K-6407-03	4.50	K-6400-32	4
3/16	7/16	1/8	K-6408-48	60.00	K-6405-04	13.50	K-6411-69	17.30	—	—	—	—
3/16	9/16	3/16	K-6413-10*	90.00	—	—	—	—	—	—	—	—
7/32	5/16	3/64	—	—	—	—	—	—	—	—	—	—
1/4	5/16	1/32	K-6408-49	15.50	—	—	K-6411-70	8.40	—	—	K-6400-35	8
1/4	3/8	1/16	K-6408-50	38.00	K-6405-06	7.00	K-6411-71	27.30	K-6407-06	7.00	K-6400-36	5
1/4	7/16	3/32	K-6408-72	41.00	K-6405-07	11.50	K-6411-72	17.40	—	—	—	—
1/4	1/2	1/8	K-6408-51	69.00	K-6405-08	16.00	K-6411-74	23.30	—	—	—	—
1/4	5/8	3/16	K-6413-20*	100.00	—	—	—	—	—	—	—	—
19/64	3/8	1/25	—	—	—	—	—	—	—	—	K-6400-41	14
5/16	3/8	1/32	—	—	—	—	—	—	—	—	—	—
5/16	7/16	1/16	K-6408-52	41.50	K-6405-09	8.00	K-6411-75	14.70	K-6407-08	7.00	K-6400-58	7
5/16	1/2	3/32	K-6408-53	60.00	K-6405-10	13.50	K-6411-76	19.60	—	—	—	—
5/16	9/16	1/8	K-6408-54	72.50	K-6405-11	37.50	K-6411-77	25.10	—	—	—	—
3/8	7/16	1/32	—	—	—	—	—	—	—	—	—	—
3/8	1/2	1/16	K-6408-12	40.00	K-6405-12	9.50	K-6411-12	21.00	K-6407-12	8.00	K-6400-62	24
3/8	9/16	3/32	K-6408-55	62.50	K-6405-15	15.50	K-6411-78	21.80	—	—	—	—
3/8	5/8	1/8	K-6408-56	88.00	K-6405-16	22.00	K-6411-79	27.70	—	—	—	—
3/8	7/8	1/4	K-6413-30*	181.00	—	—	—	—	—	—	—	—
2/5	1/2	1/20	—	—	—	—	—	—	—	—	—	—
7/16	1/2	1/32	—	—	—	—	—	—	—	—	—	—
7/16	9/16	1/16	K-6408-15	46.00	K-6405-17	12.00	—	—	—	—	—	—
1/2	9/16	1/32	—	—	—	—	—	—	—	—	—	—
1/2	5/8	1/16	K-6408-18	48.00	K-6405-18	12.50	K-6411-80	19.30	K-6407-18	10.00	K-6400-70	9
1/2	11/16	3/32	K-6408-57	79.00	K-6405-19	19.00	K-6411-19	29.50	—	—	—	—
1/2	3/4	1/8	K-6408-74	93.00	K-6405-20	26.50	K-6411-81	35.30	—	—	—	—
1/2	1⅛	5/16	K-6413-40*	272.50	—	—	—	—	—	—	—	—
9/16	5/8	1/32	—	—	—	—	—	—	—	—	—	—
9/16	3/4	3/32	—	—	—	—	—	—	—	—	—	—
5/8	13/16	3/32	K-6408-25	78.50	K-6405-25	23.50	K-6411-82	32.90	K-6407-25	15.00	—	—
5/8	7/8	1/8	K-6408-58	125.00	K-6405-27	32.50	K-6411-84	50.00	—	—	—	—
3/4	1	1/8	K-6408-31	118.50	K-6405-31	38.00	K-6411-83	50.00	K-6407-31	27.50	—	—
1	1¼	1/8	K-6408-36	148.50	K-6405-36	49.00	—	—	K-6407-35	44.50	—	—
1	1⅜	3/16	K-6408-59	276.50	K-6405-37	74.50	—	—	—	—	—	—
1¼	1⅝	3/16	—	—	K-6405-39	91.00	—	—	—	—	—	—
1¼	1¾	1/4	—	—	K-6405-46	122.00	—	—	—	—	—	—

*Suitable for vacuum use. Tygon—Reg TM Norton Co. Teflon—Reg TM E. I. DuPont de Nemours & Co. Bev-A-Line—Reg TM Thermoplastic Scientifics, Inc.

POLYETHYLENE AND NYLON TUBE FITTINGS

ose Thread (¾ in.)
Hose Thread (¾ in.)
al Pipe Thread

ARB

b	Price, ea.
	.31
	.31
	.35
	.35
	.40

	Price, ea.
	.33
	.44
	.54
	.93

Thread	Price, ea.
¼ FGHT	.63

Thread	Price, ea.
¼ FPT	.39
⅜ FPT	.42
½ FPT	.46
¾ FPT	.57

Thread	Price, ea.
½ MPT	.55
¾ MPT	.57

Polyethylene and Nylon

BLACK POLYETHYLENE: High-density, high-molecular weight, linear polyethylene. Excellent chemical compatibility, low cost, high-impact resistance at lower temperatures.

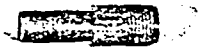
WHITE NYLON: Pure, virgin, natural Nylon resin, specifically formulated for toughness, and resistance to physical stress and abrasion.

WORKING PRESSURES:

PAR-BARB fittings are generally used in systems where pressures do not exceed 125 PSI. When used in excess of 125 PSI, PAR-BARB fittings, in all sizes, should be tested by the customer in his particular application. Operating pressures of PAR-BARB fittings are governed by ambient and fluid temperatures, type of fluid conveyed, hose or tubing used, clamping mechanism employed, and conditions of mechanical abuse.

TEMPERATURE RANGE:

Black Polyethylene: −65° to +190°F.
White Nylon: −40° to +200°F.



MALE CONNECTOR (adapter) MCB

Black High Density Linear Polyethylene Part No.	Tubing or Hose Inside Diameter (in)	Male Pipe Thread NPT (in)	Price each
15001	3/16	1/8	.20
15003	3/16	1/4	.24
15005	3/16	1/2	.26
15007	1/4	1/8	.18
15009	1/4	1/4	.18
15011	1/4	3/8	.24
15013	1/4	1/2	.29
15015	1/4	3/4	.36
15017	5/16	1/8	.21
15019	5/16	1/4	.24
15021	5/16	3/8	.24
15023	3/8	1/8	.18
15025	3/8	1/4	.18
15027	3/8	3/8	.24
15029	3/8	1/2	.29
15031	3/8	3/4	.36
15033	1/2	1/4	.24
15035	1/2	3/8	.26
15037	1/2	1/2	.35
15039	1/2	3/4	.39
15041	5/8	3/8	.35
15043	5/8	1/2	.42
15045	5/8	3/4	.34

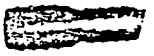
NIPPLE & NIPPLE REDUCER

Black Linear Polyethylene Part No.	Pipe Thread Size (in) Side 1	Pipe Thread Size (in) Side 2	Overall Length (in)	Hex Size (in)	Price, each
15339	1/8	1/8	1	7/16	.21
15343	1/4	1/8	1-1/8	9/16	.24
15347	1/4	1/4	1-1/4	9/16	.24
15351	3/8	1/8	1-1/8	11/16	.24
15355	3/8	1/4	1-1/4	11/16	.24
15360	3/8	3/8	1-1/4	11/16	.27
15366	1/2	1/8	1-1/4	7/8	.28
15371	1/2	1/4	1-3/8	7/8	.28
15375	1/2	3/8	1-3/8	7/8	.28
15382	1/2	1/2	1-1/2	7/8	.32
15386	3/4	3/8	1-3/8	1-1/8	.30
15391	3/4	1/2	1-1/2	1-1/8	.32
15397	3/4	3/4	1-1/2	1-1/8	.40

NYLON

MALE CONNECTOR (adapter) MCB

White Nylon Part No.	Tubing or Hose Inside Diameter (in)	Male Pipe Thread NPT (in)	Price each
15941	1/4	1/8	.36
15944	1/4	1/4	.36
15947	3/8	1/4	.38
15950	3/8	3/8	.41
15954	1/2	3/8	.52
15958	1/2	1/2	.57
15960	5/8	3/4	.68



REDUCER UNION CONNECTOR

Black High Density Linear Polyethylene Part No.	Tubing or Hose Inside Diameter Side 1 (in)	Side 2	Price each
15400	1/4	3/16	.24
15419	3/8	1/4	.24
15427	1/2	1/4	.25
15435	1/2	3/8	.28
15447	5/8	3/8	.28
15450	5/8	1/2	.29

UNION CONNECTOR

Black High Density Linear Polyethylene Part No.	Tubing or Hose Inside Diameter Both Ends (in)	Price each
15801	1/8 x 1/8	.24
15803	3/16 x 3/16	.25
15805	1/4 x 1/4	.29
15807	5/16 x 5/16	.30
15809	3/8 x 3/8	.31
15811	1/2 x 1/2	.32
15813	5/8 x 5/8	.32

MALE ELBOW

Black High Density Linear Polyethylene Part No.	Tubing or Hose Inside Diameter (in)	Male Pipe Thread MPT (in)	Price, each
15140	3/16	1/8	.40
15144	3/16	1/4	.42
15147	1/4	1/8	.42
15150	1/4	1/4	.43
15153	1/4	3/8	.49
15157	1/4	1/2	.50
15160	1/4	3/4	.51
15162	3/8	1/8	.40
15165	3/8	1/4	.42
15170	3/8	3/8	.47
15173	3/8	1/2	.51
15176	3/8	3/4	.56
15178	1/2	1/4	.42
15181	1/2	3/8	.47
15183	1/2	1/2	.51
15187	1/2	3/4	.56
15189	5/8	3/8	.51
15192	5/8	1/2	.53
15195	5/8	3/4	.61
15198	3/4	1/2	.56

ELBOW UNION

Black High Density Linear Polyethylene Part No.	Tubing or Hose Inside Diameter (in)	Price each
15604	1/4 x 1/4	.40
15608	3/8 x 3/8	.40
15612	1/2 x 3/4	.41
15616	1/2 x 3/8	.41
15620	1/2 x 1/2	.42
15624	5/8 x 5/8	.45

TEE UNION

Black High Density Linear Polyethylene Part Number	Tubing or Hose Inside Diameter (in)	Price each
15207	1/8 x 1/8 x 1/8	.40
15214	3/16 x 3/16 x 3/16	.40
15221	1/4 x 1/4 x 1/4	.40
15228	5/16 x 5/16 x 5/16	.42
15235	3/8 x 3/8 x 1/4	.42
15239	3/8 x 3/8 x 3/8	.42
15246	3/8 x 3/8 x 1/2	.42
15253	1/2 x 1/2 x 3/8	.42
15259	1/2 x 1/2 x 1/2	.47
15266	5/8 x 5/8 x 5/8	.47

MALE BRANCH TEE

Black High Density Linear Polyethylene Part No.	Tubing/Hose Inside Dia. (in)	Male Pipe Size MPT (in)	Price each
15511	3/16 x 3/16	1/8	.41
15513	3/16 x 3/16	1/4	.42
15517	1/4 x 1/4	1/8	.42
15521	1/4 x 1/4	1/4	.43
15524	1/4 x 1/4	3/8	.45
15530	3/8 x 3/8	1/4	.45
15536	3/8 x 3/8	3/8	.47
15539	3/8 x 3/8	1/2	.49
15541	1/2 x 1/2	1/4	.45
15546	1/2 x 1/2	3/8	.47
15555	1/2 x 1/2	1/2	.52

HEX HEAD PIPE PLUG

Black High Density Linear Polyethylene Part No.	Male Pipe Thread Size MPT (in)	Overall Lgth (in)	Hex Size (in)	Price, each
15660	1/8	5/8	7/16	.19
15666	1/4	23/32	9/16	.20
15672	3/8	23/32	11/16	.20
15678	1/2	27/32	7/8	.24
15682	3/4	27/32	1-1/8	.36

NYLON

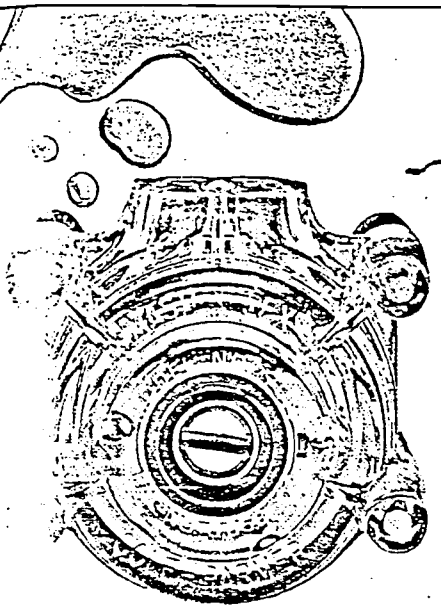
HEX HEAD PIPE PLUG

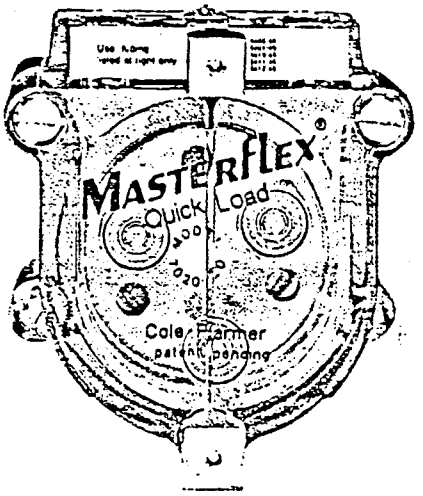
White Nylon Part No.	Male Pipe Thread Size MPT (in)	Overall Lgth (in)	Hex Size (in)	Price each
15720	1/8	5/8	7/16	.21
15724	1/4	23/32	9/16	.21
15727	3/8	23/32	11/16	.24
15729	1/2	27/32	7/8	.28
15730	3/4	27/32	1-1/8	.32

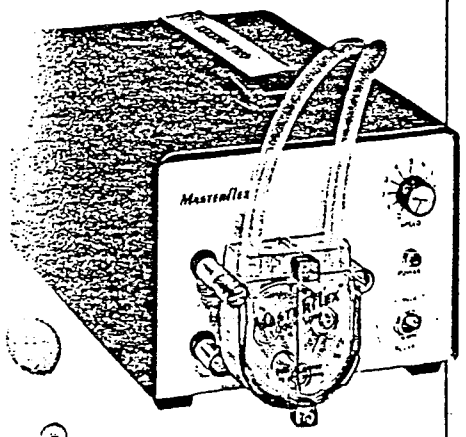
APPENDIX D-4

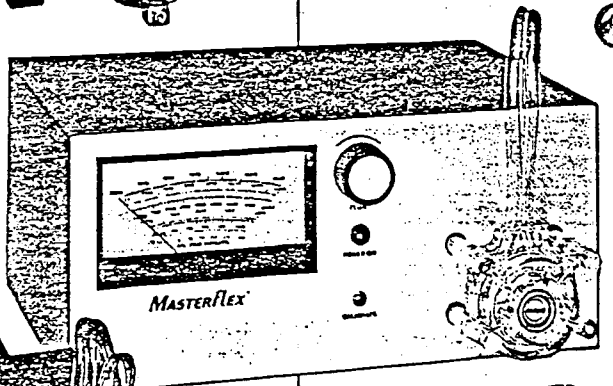
WASTE FEED PUMP SPECIFICATIONS

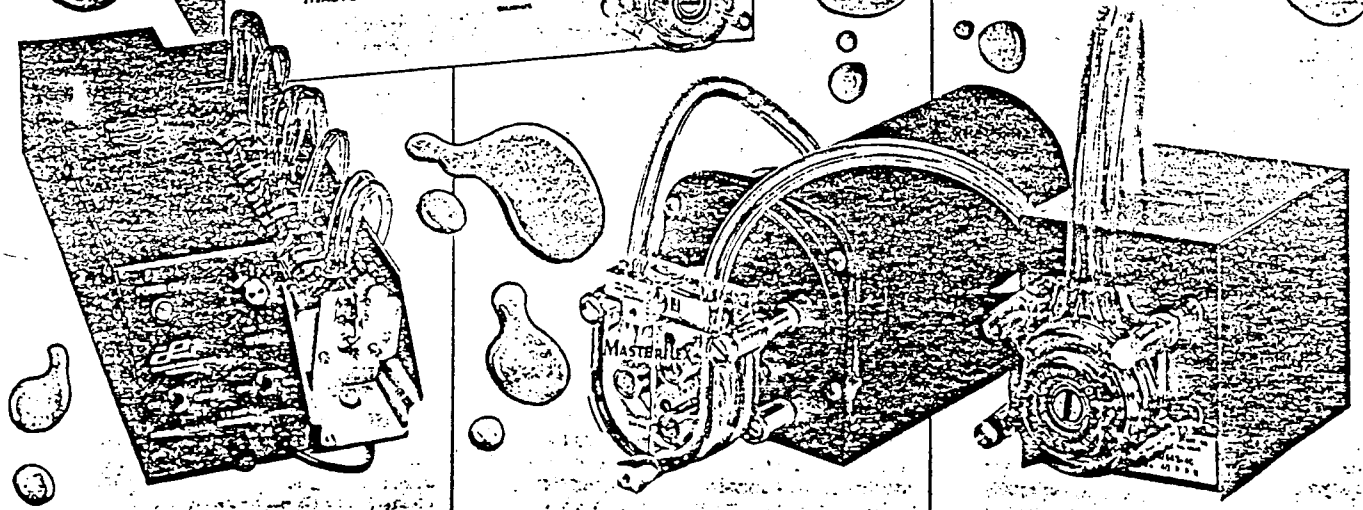
Masterflex® tubing pump systems











Instructions for ordering Masterflex® tubing pump systems are on page 428.

The unique Masterflex pumping system consists of three components: interchangeable patented pump heads, precisely extruded tubing, and a selection of drives.

The Masterflex system is designed for relatively low-flow, low-pressure pumping of liquids, gases and slurries. Flow rates range from 0.03ml/min up to 2 gpm. Maximum head pressure is 25 psi continuous, 40 psi intermittent. Masterflex pumps will pull a 24" Hg vacuum.

Great flexibility is the hallmark of Masterflex pumps. Select Standard pump heads for the widest range of flow rates. Quick Load® heads let you change tubing quickly in applications that require frequent changes to maintain fluid integrity. Pump heads may be added tang-in-groove for multi-channel pumping from one drive.

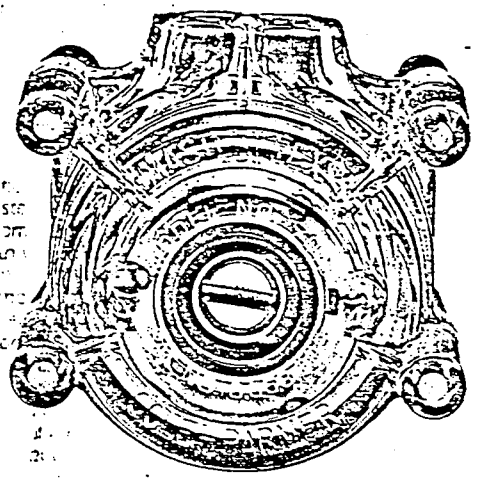
Five tubing formulations are offered to assure compatibility with your fluids. See page 442 for chemical capatibility chart.

Our full selection of drives starts on page 430. Be sure to see our new Unified variable-speed drive with precise micrometer dial speed control on page 431.

Masterflex accessories are on page 440.

Masterflex, Quick Load—Reg TM Cole-Parmer Instrument Company

MASTERFLEX® pump heads



Standard pump heads

Unique, patented design for precision single- or multi-channel pumping.

The Standard Masterflex pump head represents a major innovation in the special field of rotary peristaltic pumping. As the pivotal component in the Masterflex tubing pump system, the Standard head combines extraordinary specificity of flow rate with wide-ranging flexibility across the entire spectrum of low-pressure, low-flow pumping requirements.

The heads are molded of durable, clear Lexan® polycarbonate and feature a patented cavity to accommodate close-tolerance Masterflex tubing. Polyphenylene sulfide heads may be special-ordered for handling solvents. Rotors can be ordered in cold-rolled steel or chemical-resistant stainless steel.

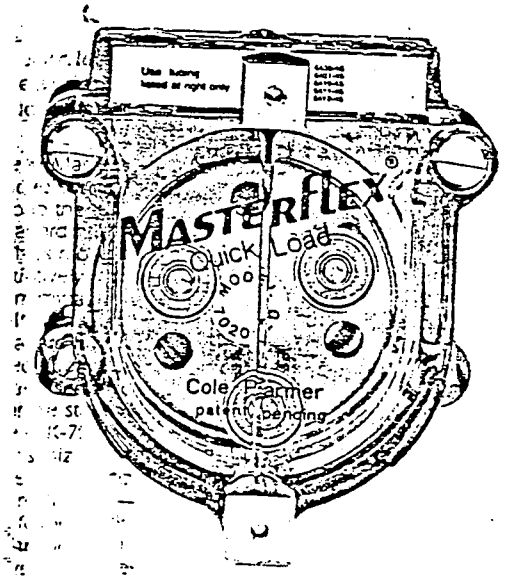
Standard heads give you the benefit of attaching up to 4 heads in tandem for multi-channel pumping. If your operation requires more than one head, see page 428 for specially-designed mounting hardware. (For driving 5 to 10 separate pump heads, see drives on page 433.)

These heads provide a broad range of flows, from 0.06 to 2280ml/min—for precision dispensing as well as bulk pumping. One rotor revolution of the head yields a fixed amount of fluid proportional to tubing size. Flow rates accurate to one-thousandth of a ml/min can be determined from rpm information. (Special heads and drives that provide lower or greater flow rates are listed later in this publication.)

To select the Standard head that best meets your needs, consult the table below.

Protected by U.S. Patent no. 3,358,069.

Standard pump heads						Specifications for Standard heads			
Cat. no.	Rotor and bearings	Price	Cat. no.	Rotor and bearings	Price	Flow rate: ml/revolution*	Maximum head pressure: Continuous	Maximum head pressure: Intermittent	Max. vacuum
K-7013-20	Cold-rolled steel	$52.50	K-7013-21	Stainless steel	$98.50	0.06ml	20 psi	35 psi	24" Hg
K-7014-20	Cold-rolled steel	52.50	K-7014-21	Stainless steel	98.50	0.21ml	20 psi	35 psi	24" Hg
K-7016-20	Cold-rolled steel	52.50	K-7016-21	Stainless steel	98.50	0.80ml	20 psi	35 psi	24" Hg
K-7015-20	Cold-rolled steel	52.50	K-7015-21	Stainless steel	98.50	1.67ml	25 psi	40 psi	24" Hg
K-7017-20	Cold-rolled steel	52.50	K-7017-21	Stainless steel	98.50	2.80ml	20 psi	35 psi	24" Hg
K-7018-20	Cold-rolled steel	52.50	K-7018-21	Stainless steel	98.50	3.80ml	20 psi	35 psi	12" Hg



Quick Load® pump heads

Masterflex precision and quality in a convenient head... when you need frequent tubing changes.

The Masterflex Quick Load pump head adds the convenience of simplified tubing installation to the features and benefits offered by the Standard head. It is particularly valuable in applications requiring numerous tubing changes over a relatively short period of time, to prevent cross-contamination.

Built to the same rigorous specifications as Standard heads, the Quick Load housing is molded of clear Lexan® polycarbonate and the rotor assembly and two sets of sealed ball bearings are stainless steel.

The K-7020-20 Quick Load accommodates one tubing size, while the K-7020-40 is a triple tubing size head that accommodates 3 different sizes of Masterflex tubing—one size at a time. The flow range for the Quick Load single size is identical to the Standard K-7015-series. The triple tubing size delivers flow ranges identical to the K-7013-, K-7014- and K-7016-series. See table below for flow specifications that best suit your needs.

Unlike the Standard heads above, Quick Load heads cannot be attached in tandem. They can be used, however, as an end unit in a multi-channel series of Standard heads. See page 428 for mounting hardware.

Tubing installation is simplified with Quick Load. Just loosen two retaining nuts and swing out the cover halves. Place tubing around the rotor assembly, swing in the cover halves and tighten nuts to secure. See page 441 for illustrated loading directions.

Protected by Patent numbers:
4,179,249 4,138,205 4,231,725

Quick Load—Reg TM Cole-Parmer Instrument Co.
Masterflex—Reg TM Cole-Parmer Instrument Co.

Quick Load pump heads				Specifications for Quick Load heads		
Cat. no.	Size	Price	Flow rate: ml/revolution*	Maximum head pressure: Continuous	Maximum head pressure: Intermittent	Max. vacuum
K-7020-40 Triple size (accommodates one size tubing at time)	(A)	$125.00	0.06ml	20 psi	35 psi	24" Hg
	(B)		0.21ml	20 psi	35 psi	24" Hg
	(C)		0.80ml	20 psi	35 psi	24" Hg
K-7020-20 Single size	—	$125.00	1.67ml	25 psi	40 psi	24" Hg

*Flow rates for all Masterflex heads can be converted to ml/min by multiplying flow per revolution by running speed of the drive:
ml/rev x rpm = ml/min

Example: a head with flow rate of 0.06ml/revolution used with a fixed speed drive at 600 rpm yields a flow rate of 36ml/min.

Lexan—Reg TM General Electric Plastics

Precision-extruded close-tolerance *Masterflex*® tubing

Tu[illegible]g for the Masterflex system is manufac-[illegible] in five formulations to meet most pump[illegible] requirements. All Masterflex tubing is preci[illegible]-extruded to stringent specifications.

Be[illegible]se the tubing and pump head form an inform[illegible] operating unit, only Masterflex tubing will [illegible] properly. Commercially available tubing will [illegible] perform to our strict specifications.

Cho[illegible] from the following formulations:

1) T[illegible]n® (R 3603)—a low-cost, non-corrosive tub[illegible]r general applications in the laboratory. Exc[illegible] for vacuum pumping.

2) T[illegible]n® special—formulated to transport hydrocarbons. It's best suited for gasoline, fuels, oils and lubricants.

3) Tygon® food—designed specifically for use in pumping food products. Meets USDA and FDA standards.

4) Viton®—for exceptional chemical resistance against corrosives and solvents. This fluoroelastomer has the shortest tubing life.

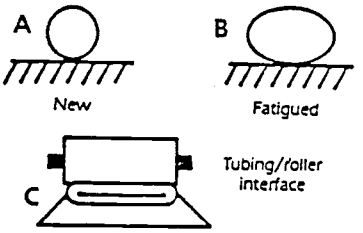
5) Silicone—meets USDA and FDA standards. Silicone has the widest temperature range and the longest life. It can withstand pump head squeezing action at 200 rpm for up to 450 hours before losing its elastic memory.

Both silicone and Viton fluoroelastomer tubing can be autoclaved by standard procedures. Tygon can be sterilized by two methods: 1) using one of a number of germicides or gases based on ethylene oxide in a gas sterilizer; 2) steaming to a maximum of 250°F at 15 psi for 30 minutes and then cooling at 150°F in dry heat for 2½ hours maximum.

The tables below give complete information on which tubing to order for the flow rates, fluids and temperatures you may be using.

P[illegible]ng life of *Masterflex*® tubing

[illegible]sterflex tubing can be used for accurate-[illegible]olume pumping for long periods of time, b[illegible] will not last indefinitely. Even silicone tub-in[illegible] its potential for 450 hours of operation at 20[illegible], has limitations. At the right, we have ill[illegible]ed the difference between tubing that is n[illegible] and tubing that has fatigued (B). Because t[illegible]rs continuously pass over the tubing and squeeze it down (C), the tubing loses its elastic memory over time and will not spring back to its original shape as readily. When fatigue occurs, you can simply pull the length of tubing to a section that has not been subjected to the rigors of the tubing/roller interface—and continue pumping.



T[illegible]g applications suitability table

[illegible]ings given below are general and based on [illegible]erage applications. We recommend you s[illegible] a sample of the tubing to an immersion t[illegible] the fluid to be pumped, particularly if you a[illegible]orking with hazardous materials. We can assume no responsibility for tubing failure in specific applications. The table on page 442 gives more detailed information on chemical compatibility.

Legend: "E"=Excellent; "G"=Good; "F"=Fair; "P"=Poor; "N"=Not recommended; "A"=Autoclavable

[illegible]bing [illegible]ries no.	Type	Applications suitability						Temperature limits		Applications	Tubing life[1] at 550 rpm
		Pressure	Vacuum	Corrosives		Solvents					
				Acids	Bases	General	Highly active*	F°	C°		
[illegible]-6408	Tygon® (R 3603)	E*	E*	G	G	P	N	−20 to +165	−29 to +74	General	50 hrs
[illegible]-6401	Tygon® special	E*	E*	F	N	P	N	+10 to +180	−12 to +83	Hydrocarbons	50 hrs
[illegible]-6419	Tygon® food	E*	E*	P	P	N	N	0 to +180	−18 to +83	Food	40 hrs
K-6412	Viton®	E	E	E	E	G	G	−10 to +400	−23 to +205	Corrosives	30 hrs
K-6411	Silicone	F	E*	F	F	P	P	−80 to +500	−62 to +260	Food, bio./pharm.	150 hrs[2]

*Tube used in K-7017 and K-7018 heads is rated F

Tygon—Reg TM Norton Co.

Viton—Reg TM E.I. DuPont de Nemours and Co.

[1]Approximate life in pump head, subjected to the stress of peristaltic action. Tubing life is inversely proportional to pump speed; halving the speed should double the life.

[2]Except for K-6411-09, which has a 70-hour life at 550 rpm.

Ordering information table

The tubing listed below has been manufactured to our exact dimensions, and subjected to quality control checking by an optical comparator for compatibility with Masterflex pump heads. If other tubing is inserted into a Masterflex pump head, malfunctions such as tubing failure, tubing slippage, decreased pressure or vacuum deficiency may occur.

Before ordering tubing, we recommend that you consult the Tubing Applications Suitability Table (above) and the Chemical Compatibility Chart (page 442) for guidelines for determining the appropriate tubing for your requirements.

Save 20% on the purchase of 100 feet of one size and one formulation of Tygon tubing. Save 10% on 50 feet or more of Viton or silicone tubing.

Ordering information		Standard Masterflex heads						Quick Load pump heads			
		K-7013-series	K-7014-series	K-7016-series	K-7015-series	K-7017-series	K-7018-series	Single size	Triple size head (Accommodates 1 size at a time)		
Inner dimensions		0.031"	0.065"	0.125"	0.192"	0.255"	0.313"	0.192"	0.031"	0.065"	0.125"
Outer dimensions		0.162"	0.194"	0.251"	0.392"	0.386"	0.439"	0.392"	0.162"	0.194"	0.251"
Tygon® (R 3603)	Cat. no.	K-6408-41	K-6408-43	K-6408-02	K-6408-45	K-6408-06	K-6408-09	K-6408-45	K-6408-41	K-6408-43	K-6408-02
	Price/50 ft	$13.00	$15.00	$20.00	$41.50	$32.00	$40.50	$41.50	$13.00	$15.00	$20.00
Tygon® special	Cat. no.	K-6401-41	K-6401-43	K-6401-44	K-6401-45	K-6401-47	K-6401-48	K-6401-45	K-6401-41	K-6401-43	K-6401-44
	Price/50 ft	$12.50	$16.00	$20.50	$43.00	$31.50	$44.00	$43.00	$12.50	$16.00	$20.50
Tygon® food tubing	Cat. no.	K-6419-41	K-6419-43	K-6419-02	K-6419-45	K-6419-06	K-6419-09	K-6419-45	K-6419-41	K-6419-43	K-6419-02
	Price/50 ft	$12.50	$16.00	$20.50	$43.00	$35.50	$44.00	$43.00	$12.50	$16.00	$20.50
Viton® tubing	Cat. no.	K-6412-41	K-6412-43	K-6412-44	K-6412-45	K-6412-47	K-6412-48	K-6412-45	K-6412-41	K-6412-43	K-6412-44
	Price/foot	$1.61	$2.16	$3.39	$7.13	$5.68	$6.36	$7.13	$1.61	$2.16	$3.39
Silicone tubing	Cat. no.	K-6411-41	K-6411-43	K-6411-02	K-6411-45	K-6411-47	K-6411-09	K-6411-45	K-6411-41	K-6411-43	K-6411-02
	Price/25 ft	$18.75	$30.00	$25.00	$42.50	$40.00	$37.50	$42.50	$18.75	$30.00	$25.00

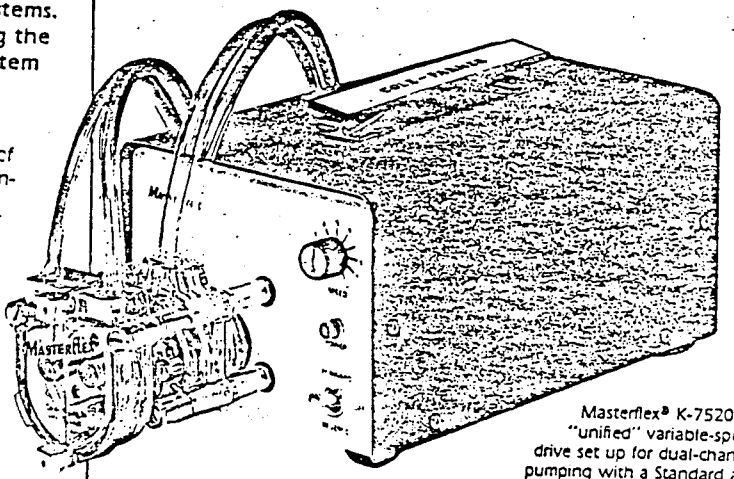
How to order *Masterflex*® components

Follow the steps below to specify Masterflex® pump systems. Each step explains the options you have for designing the pumping system you need. Your Masterflex® pump system will consist of a drive, one or more pump heads and appropriate tubing.

1 Select an appropriate pump drive by determining the amount of flexibility you require. If you need to pump a single volume constantly or repeatedly, order a fixed-speed drive. It is available in AC- and DC-powered models.

We recommend variable-speed drives for changing flow requirements—from metering and dispensing up to chemical feed and transfer jobs. Choose component variable-speed controller and motor drives for general applications: a unified variable-speed drive, calibrated for greater settability; or integral variable-speed drives, which can be controlled remotely by a 4-20 mA signal. DC-powered models are also available. Console variable-speed drives display flow ranges on an analog dial for direct meter readings of flow. The 5-channel and 10-channel drives operate 1 to 5 or 1 to 10 pump heads at the same rpm setting. Servodyne drives maintain the correct rpm setting regardless of torque load using a built-in tachometer feedback...ideal for laboratory research jobs.

High-capacity and environmental sampling pump drives are described on pages 436-439.



Masterflex® K-7520-00 "unified" variable-speed drive set up for dual-channel pumping with a Standard and Quick Load® head, each loaded with Tygon® tubing, plus hardware

2 Select the drive by rpm rating. Since each pump head produces a fixed ml output per revolution of the drive shaft, the flow rate is directly related to the rpm rating. The table below lists several drive types with rpm ratings available and page numbers for ordering.

Drive types	Rpm ratings availabe	Page
Variable speed	6-600 and 1-100	430
Fixed speed	1, 2, 6, 12, 20, 30, 60, 100 and 575	431
Unified variable speed	6-600 and 1-100	431
Integral variable speed	30-600 and 5-100	432
DC-powered fixed speed	120 and 600	432
DC-powered variable speed	20-90 and 100-500	432
Console variable speed	5-500 and 1-100	433
5- and 10-channel	5-100	433
Servodyne	3-300 and 3-3000 in one	434

3 Select the pump head that is easiest to use for your application. Standard pump heads offer the widest number of flow ranges. Tubing is relatively easy to re-load as necessary. Quick Load® pump heads are ideal for applications where tubing must be changed frequently because of cross-contamination or sterilization requirements.

4 Choose pump head materials. Standard pump heads come with Lexan® polycarbonate housings for routine jobs; or with polyphenylene sulfide housings for greater chemical resistance. Specify a rotor assembly in cold-rolled steel or stainless steel. Stainless steel is preferred for greater chemical resistance.

Quick Load heads are Lexan polycarbonate with stainless steel rotor assembly only.

5 Select the right pump head series for your flow requirements. Check the flow rates listed with the individual drive you have specified. You can calculate the flow rate by multiplying the ml per revolution figure by the rpm rating of the drive (see table at left). Representative flow rates are provided in the table below.

Pump heads	Standard Masterflex® pump heads						Quick Load Masterflex® pump heads			
	K-7013 series	K-7014 series	K-7016 series	K-7015 series	K-7017 series	K-7018 series	K-7020-20 single tubing size	K-7020-40 triple tubing size (accommodates 3 tubing sizes, one size at a time)		
								Size A	Size B	Size C
Flow rate: ml per revolution	0.06ml	0.21ml	0.80ml	1.67ml	2.80ml	3.80ml	1.67ml	0.06ml	0.21ml	0.80ml
Drive speed	Pump head flow rates in ml/min for drive speeds shown at left									
600 rpm (fixed)	36	126	480	1000	1680	2280	1000	36	126	480
100 rpm (fixed)	6	21	80	167	280	380	167	6	21	80
30-600 rpm (variable)	1.8-36	6.3-126	24-480	50-1000	84-1680	114-2280	50-1000	1.8-36	6.3-126	24-480
6-600 rpm (variable)	0.36-36	1.26-126	4.8-480	10-1000	16.8-1680	22.8-2280	10-1000	0.36-36	1.26-126	4.8-480
5-100 rpm (variable)	0.3-6	1.0-21	4.0-80	8.3-167	14-280	19-380	8.3-167	0.3-6	1.0-21	4.0-80
1-100 rpm (variable)	0.06-6	0.21-21	0.80-80	1.67-167	2.80-280	3.80-380	1.67-167	0.06-6	0.21-21	0.80-80

6 Select one of the five tubing formulations that will be compatible with the fluid you are handling. Choose from Viton®, silicone and three formulations of Tygon® tubing, manufactured to Masterflex® specifications. Check the Tubing Compatibility Table on page 442 for more information on chemical resistance and suitability.

7 Specify the right size tubing for the pump head you have selected. Each pump head series accommodates one size tubing, except the triple-size Quick Load. Be sure to order the correct catalog number from page 427 for the formulation and size you need.

8 Multi-channel pumping capability with a single drive is a unique Masterflex benefit. Add up to four pump heads onto the same drive, tang-in-groove fashion, using the additional mounting hardware listed at right. Check the description of the drive you have selected and note the number of pump heads it will accommodate.

Standard heads may be added onto one another, and a Quick Load head may be added to a Standard head. Quick Load heads may not be added to one another.

No. of heads	Standard head hardware				Quick Load hardware	
	Plated steel		Stainless steel		Plated steel	
2	K-7013-03	$3.00	K-7013-05	$ 5.75	K-7020-02	$21.00
3	K-7013-06	5.00	K-7013-08	17.00	K-7020-03	21.00
4	K-7013-07	7.00	K-7013-09	18.00	K-7020-04	21.00

9 Order Masterflex pump accessories to complete your system. See page 440 for flow integrator, dispenser/timer and tachometer.

Lexan—Reg TM General Electric Plastics **Tygon**—Reg TM Norton Co.
Viton—Reg TM E.I. DuPont de Nemours & Co.
Masterflex, Quick Load—Reg TM Cole-Parmer Instrument Co.

MASTERFLEX® specifications and ordering summary

These tables are color-coded to match pump heads, proper tubing size, and drive flow specifications. Be sure to follow the nine steps on the opposite page before ordering. Cole-Parmer gives you a **free** 3-ft length of K-6408 Tygon® tubing with each pump head.

Flow specifications

Data given below are approximate, determined under the following conditions: inlet 0 psig; outlet 0.5 psig; 22°C water circulant, inlet and outlet tubing each about 2 feet long. Flow at maximum continuous head pressure is about 90% of flow at 0 head pressure. For the K-7015 series Standard heads and the K-7020-20 Quick Load® head, flow is somewhat less than 90% at continuous head pressure.

Pump heads		Standard Masterflex® pump heads						Quick Load Masterflex® pump heads			
		K-7013 series	K-7014 series	K-7016 series	K-7015 series	K-7017 series	K-7018 series	K-7020-20 single tubing size	K-7020-40 triple tubing size (accommodates 3 tubing sizes, one size at a time)		
									Size A	Size B	Size C
Flow rate: ml per revolution		0.06ml	0.21ml	0.80ml	1.67ml	2.80ml	3.80ml	1.67ml	0.06ml	0.21ml	0.80ml
Max. continuous head pressure		20 psi	20 psi	20 psi	25 psi	20 psi	20 psi	25 psi	20 psi	20 psi	20 psi
Max. intermittent head pressure		35 psi	35 psi	35 psi	40 psi	35 psi	35 psi	40 psi	35 psi	35 psi	35 psi
Maximum vacuum		24" Hg	24" Hg	24" Hg	24" Hg	24" Hg	12" Hg	24" Hg	24" Hg	24" Hg	24" Hg
Pump head ordering information—specify rotor materials and bearings											
Cold-rolled steel	Cat. no.	K-7013-20	K-7014-20	K-7016-20	K-7015-20	K-7017-20	K-7018-20	Quick Load heads are available only in stainless steel with sealed ball bearings			
	Price	$52.50	$52.50	$52.50	$52.50	$52.50	$52.50				
Stainless steel (sealed ball bearings)	Cat. no.	K-7013-21	K-7014-21	K-7016-21	K-7015-21	K-7017-21	K-7018-21	K-7020-20	← K-7020-40 →		
	Price	$98.50	$98.50	$98.50	$98.50	$98.50	$98.50	$125.00	← $125.00 →		
Extra-shaft pump heads for UltraMasterflex systems K-7555-20, -40 and K-7557-30, -50; K-7547-00 variable-speed and K-7571-20 fixed-speed hazardous environment drives											
Cold-rolled steel	Cat. no.	K-7013-00	K-7014-00	K-7016-00	K-7015-00	K-7017-00	K-7018-00	Quick Load heads are available only in stainless steel with sealed ball bearings			
	Price	$52.50	$52.50	$52.50	$52.50	$52.50	$52.50				
Stainless steel (sealed ball bearings)	Cat. no.	K-7013-10	K-7014-10	K-7016-10	K-7015-10	K-7017-10	K-7018-10	K-7020-10	← K-7020-30 →		
	Price	$98.50	$98.50	$98.50	$98.50	$98.50	$98.50	$125.00	← $125.00 →		
Tubing for Masterflex pumps—select the formulation, then the appropriate size											
Inner dimensions		0.031"	0.065"	0.125"	0.192"	0.255"	0.313"	0.192"	0.031"	0.065"	0.125"
Outer dimensions		0.162"	0.194"	0.251"	0.392"	0.386"	0.439"	0.392"	0.162"	0.194"	0.251"
Tygon® (R 3603)	Cat. no.	K-6408-41	K-6408-43	K-6408-02	K-6408-45	K-6408-06	K-6408-09	K-6408-45	K-6408-41	K-6408-43	K-6408-02
	Price/50 ft	$13.00	$15.00	$20.00	$41.50	$32.00	$40.50	$41.50	$13.00	$15.00	$20.00
Tygon® special	Cat. no.	K-6401-41	K-6401-43	K-6401-44	K-6401-45	K-6401-47	K-6401-48	K-6401-45	K-6401-41	K-6401-43	K-6401-44
	Price/50 ft	$12.50	$16.00	$20.50	$43.00	$31.50	$44.00	$43.00	$12.50	$16.00	$20.50
Tygon® food tubing	Cat. no.	K-6419-41	K-6419-43	K-6419-02	K-6419-45	K-6419-06	K-6419-09	K-6419-45	K-6419-41	K-6419-43	K-6419-02
	Price/50 ft	$12.50	$16.00	$20.50	$43.00	$35.50	$44.00	$43.00	$12.50	$16.00	$20.50
Viton® tubing	Cat. no.	K-6412-41	K-6412-43	K-6412-44	K-6412-45	K-6412-47	K-6412-48	K-6412-45	K-6412-41	K-6412-43	K-6412-44
	Price/ft	$1.61	$2.16	$3.39	$7.13	$5.68	$6.36	$7.13	$1.61	$2.16	$3.39
Silicone tubing	Cat. no.	K-6411-41	K-6411-43	K-6411-02	K-6411-45	K-6411-47	K-6411-09	K-6411-45	K-6411-41	K-6411-43	K-6411-02
	Price/25 ft	$18.75	$30.00	$25.00	$42.50	$40.00	$37.50	$42.50	$18.75	$30.00	$25.00

Tubing discounts: Save 20% on 100 feet or more of one size and one formulation of Tygon tubing. Save 10% on 50 feet or more of Viton or silicone tubing.

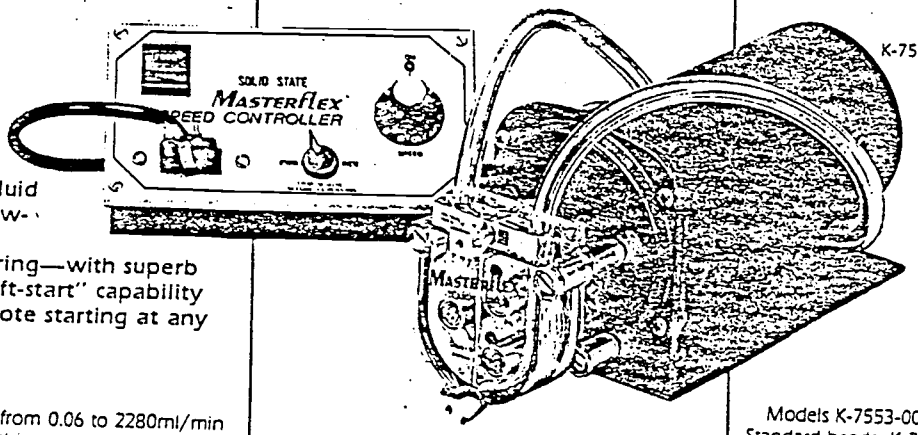
Pump head flow rates in ml/min for selected MASTERFLEX® drives

Drive cat. no.	K-7013	K-7014	K-7016	K-7015	K-7017	K-7018	Single size	Size A	Size B	Size C
K-7553-00 Variable speed	0.36-36	1.26-126	4.8-480	10-1000	16.8-1680	22.8-2280	10-1000	0.36-36	1.26-126	4.8-480
K-7553-10 Variable speed	0.06-6	0.21-21	0.8-80	1.67-167	2.8-280	3.8-380	1.67-167	0.06-6	0.21-21	0.8-80
K-7520-00 Unified variable	0.36-36	1.26-126	4.8-480	10-1000	16.8-1680	22.8-2280	10-1000	0.36-36	1.26-126	4.8-480
K-7520-10 Unified variable	0.06-6	0.21-21	0.8-80	1.67-167	2.8-280	3.8-380	1.67-167	0.06-6	0.21-21	0.8-80
K-7534-10 Integral variable	1.8-36	6.3-126	24-480	50-1000	84-1680	114-2280	50-1000	1.8-36	6.3-126	24-480
K-7534-30 Integral variable	0.3-6	1.0-21	4.0-80	8.4-167	14-280	19-380	8.4-167	0.3-6	1.0-21	4.0-80
K-7533-10 DC-powered fixed	7.2	25.2	96	200.4	336	456	200.4	7.2	25.2	96
K-7533-20 DC-powered variable	1.2-5.4	4.2-18.9	16-72	33.4-150.3	56-252	76-342	33.4-150.3	1.2-5.4	4.2-18.9	16-72
K-7533-40 DC powered variable	6-30	21-105	80-400	167-835	280-1400	380-1900	167-835	6-30	21-105	80-400
K-7531-00 AC-powered fixed	34.5	120.75	460	958.33	1610	2185	958.33	34.5	120.75	460
K-7562-00 Console variable	1-30	5-110	10-400	20-800	20-1400	30-1890	20-800	1-30	5-110	10-400
K-7562-10 Console variable	0.2-6	0.5-22	2-80	4-160	4-280	6-378	4-160	0.2-6	0.5-22	2-80
K-7567-00 Five-channel	0.3-6	1.0-21	4.0-80	8.3-167	14-280	19-380	8.3-167	0.3-6	1.0-21	4.0-80
K-7568-00 Ten-channel	0.3-6	1.0-21	4.0-80	8.3-167	14-280	19-380	8.3-167	0.3-6	1.0-21	4.0-80
K-7557-30, -50 Standard Servodyne	0.6-36	2.1-126	8-480	16-1000	28-1680	38-2280	16-1000	0.6-36	2.1-126	8-480
K-7555-20, -40 Master Servodyne*	0.108-2160	0.378-7560	1.440-28,800	3.006-60,120	5.040-100,800	6.840-36,800	3.006-60,120	0.108-2160	0.378-7560	1.440-28,800

*Flow rate is stated in ml/hr. Figures were generated by multiplying the ml/min per revolution of each pump head times the rpm of the pump drive.

Masterflex, Quick Load—Reg TM Cole-Parmer Instrument Co. Tygon—Reg TM Norton Co. Viton—Reg TM E.I. DuPont de Nemours & Co.

MASTERFLEX® variable-speed drives



K-7553- and K-7554-series variable-speed drives with full-range linear control and a wide speed range

Our most popular drives...designed for flexible, dependable fluid handling—from low-flow dispensing to high-flow transferring—with superb linearity...plus "soft-start" capability for non-surge, remote starting at any setting.

Variable flow rates from 0.06 to 2280ml/min are possible with this versatile drive, available in two rpm ranges. Flow rates are maintained electronically...with automatic compensation for changes in load torque demands. This translates to metering accuracy—especially at high speeds—for sensitive laboratory or industrial applications.

The permanent magnet DC motor, with increased torque at high and low speeds, is rated for continuous use. "Soft-starting" (gentle acceleration up to speed) and long brush life promote long service life. Allow additional start-up time for "soft-starting" in remote, auto-timed dispensing or metering.

Solid-state speed control is calibrated at the high end of the rpm range for good linear control and metering accuracy. The front-panel on/off dial adjusts the flow, taking the drive through the entire rpm range (1-to-100 or 6-to-600). And flow direction is reversible...a feature with intrinsic value for many applications.

Models K-7553-00 and K-7554-00 accept 1 or 2 Standard heads; K-7553-10 and K-7554-10 have 100:1 reduction gears for high-torque multi-channel pumping with as many as 4 heads. Select drives and heads from table below; see page 427 for tubing.

Drive housing is rugged steel with a chemically-resistant epoxy finish. Separate controller with 6-ft connecting cord permits remote panel-mounting. A 6-ft, 3-wire line cord is included. The 100-130 VAC drives have a standard plug; 200-230 VAC drives have a European universal plug. Shpg wt 10 lbs (4.5kg).

Drive catalog number	Motor rpm	No. of Std. heads accepted	Power requirement	Price	Flow ranges in ml/min with Standard or Quick Load pump heads					
					K-7013-20, -21	K-7014-20, -21	K-7016-20, -21	K-7015-20, -21	K-7017-20, -21	K-7018-20, -21
					K-7020-40 Quick Load mole-size head			K-7020-20	—	—
K-7553-00	6 to 600	1 or 2	110 to 130 VAC	$285.00	0.36 to 36	1.26 to 126	4.8 to 480	10 to 1000	16.8 to 1680	22.8 to 2280
K-7554-00	6 to 600	1 or 2	200 to 260 VAC	299.00	0.36 to 36	1.26 to 126	4.8 to 480	10 to 1000	16.8 to 1680	22.8 to 2280
K-7553-10	1 to 100	Up to 4	100 to 130 VAC	297.00	0.06 to 6	0.21 to 21	0.8 to 80	1.67 to 167	2.8 to 280	3.8 to 330
K-7554-10	1 to 100	Up to 4	200 to 260 VAC	315.00	0.06 to 6	0.21 to 21	0.8 to 80	1.67 to 167	2.8 to 280	3.8 to 330

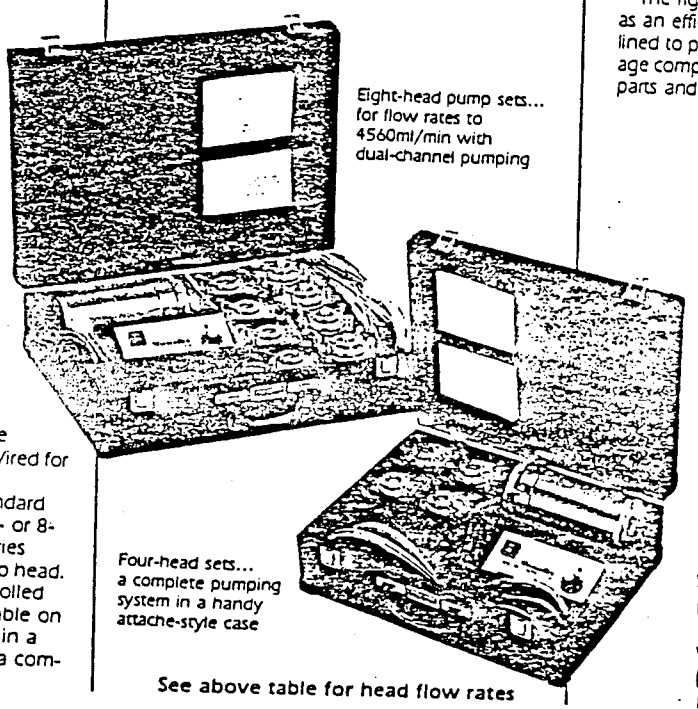
MASTERFLEX® pump sets

A compact, attache-style case, fitted with all the components you need for a complete variable-speed Masterflex system...ideal for experimental lab work or research & development applications.

Here are two versatile pumping kits designed especially for product designers, pilot plant specifiers, prototype makers or systems designers... any lab or industrial experimenter.

Each kit comes complete with a variable-speed drive (6-600 rpm) and solid-state speed controller to assure steady flow rate at the set speed. (See the K-7553-00 and K-7554-00 drives, above.) Wired for 50/60 Hz.

Also included in the kits is a set of Standard Masterflex pump heads (your choice of 4- or 8-head sets) and a 3-ft length of K-6408-series Tygon tubing (see page 427) for each pump head. All of the heads are equipped with cold-rolled steel rotors; stainless steel rotors are available on special request. Both kits come packaged in a durable custom attache case with an extra compartment for tools.



Eight-head pump sets... for flow rates to 4560ml/min with dual-channel pumping

Four-head sets... a complete pumping system in a handy attache-style case

See above table for head flow rates

The rigid, vinyl-covered carrying case doubles as an efficient storage box, cushioned and felt-lined to protect the components. A separate storage compartment is provided for your tools, spare parts and accessories.

Four-head set

Provides a wide range of flow rates up to 2280ml/min. The 4 Standard pump heads are: K-7013-20, K-7016-20, K-7015-20 and K-7018-20.

K-7558-10 Four-head set. 115 VAC. Shpg wt 21 lbs (9.5kg) $525.00

K-7558-20 Four-head set. 230 VAC. Shpg wt 21 lbs (9.5kg) $555.00

Eight-head set

Allows flow rates to 4560ml/min in dual-channel pumping with 2 heads. Kit contains 2 each of the K-7013-20, K-7016-20, K-7015-20 and K-7018-20 pump heads.

K-7558-30 Eight-head set. 115 VAC. Shpg wt 27 lbs (12.3kg) $610.00

K-7558-40 Eight-head set. 230 VAC. Shpg wt 27 lbs (12.3kg) $660.00

Masterflex - Reg TM Cole-Parmer Instrument Co.

MASTERFLEX®

variable speed drives

Drive catalog number		
	7553-00	7553-10
	7554-00	7554-10

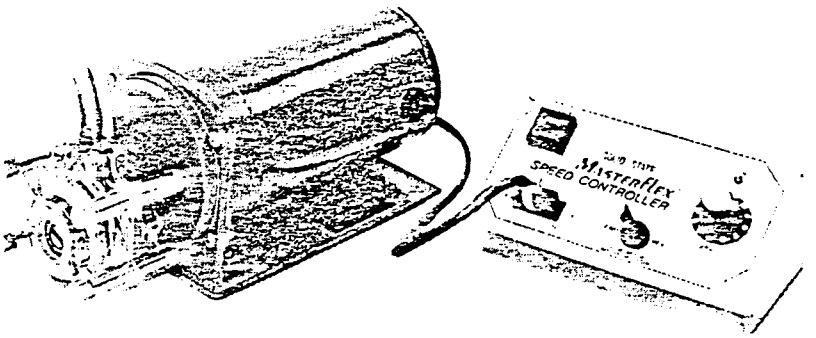
Operating and Maintenance Instructions Manual

Cole-Parmer Instrument Co.
7425 North Oak Park Ave.
Chicago, Illinois 60648
312/647-7600

MASTERFLEX®

variable speed drives

Drive catalog number	7553-00	7553-10
	7554-00	7554-10



Cole Parmer Instrument Co.
7425 N. Oak Park Avenue
Chicago, Illinois 60648
(312) 647-7600

A-1299-109
EDITION 3782

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GENERAL DESCRIPTION

This most versatile electric drive incorporates a new permanent magnet D.C. motor, with increased torque at high speeds, is totally closed and permanently lubricated. Extremely quiet in operation and with long brush life, this motor drive system automatically compensates for changes in load torque demands. Utilizing a new, solid-state control circuit assures accurate, dependable speed (flow) control. Excellent speed regulation, even with line voltage and load variations, is designed in the rugged electronic control. Flow direction is reversible. "Soft-start" and smooth, gradual acceleration to speed setting is provided when line power switch is from controller.

Drive catalog number	Motor rpm	Power requirement	No. of std heads accepted
7553-00	6 to 600	100 to 130 VAC	1 or 2
7554-00	6 to 600	200 to 260 VAC	1 or 2
7553-10	1 to 100	100 to 130 VAC	Up to 4
7554-10	1 to 100	200 to 260 VAC	Up to 4

AC voltage can be either 50 or 60 Hz.

OPERATION

Operation of the variable speed drive is simple: select and install the desired pump head and tubing, connect the drive to the controller, and connect the controller line cord to a grounded, three-wire AC receptacle. Adjust the speed control knob to the desired speed. If necessary, use the reversing switch to change the direction of the pump's rotation (stop the pump before changing the direction). CAUTION: Do not disconnect motor from control with power switch in "on" position.

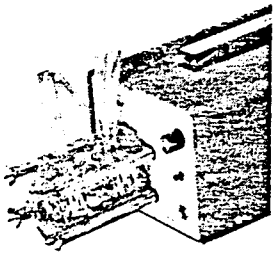
Multi-channel pumping: Standard pump heads only can be cascaded for one, two, three or four-channel pumping depending on the drive. For multi-channel pumping the following hardware is needed:

7013-03 Hardware for 2 heads; plated steel
7013-05 Hardware for 2 heads; stainless steel
7013-06 Hardware for 3 heads; plated steel
7013-08 Hardware for 3 heads; stainless steel
7013-07 Hardware for 4 heads; plated steel
7013-09 Hardware for 4 heads; stainless steel

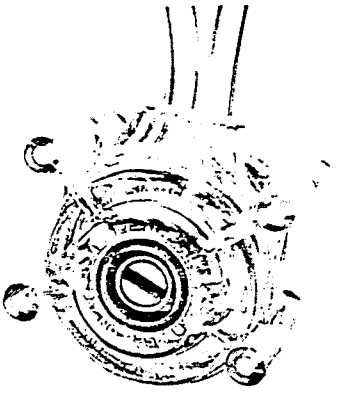
MASTERFLEX® INTERCHANGEABLE PUMP HEADS

Standard heads attach directly to most Masterflex® drive units. They can be cascaded for multi-channel pumping . . . depending on the drive unit, you can attach up to four heads, one in front of the other, to the same drive.

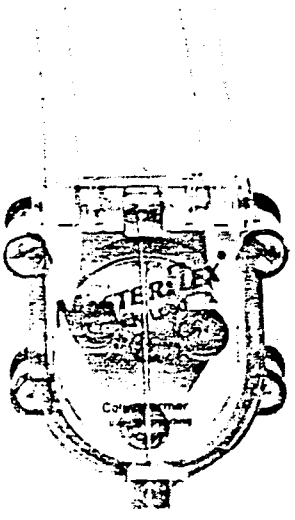
Standard heads are molded of crystal-clear Lexan® polycarbonate. Shafts, rotor assemblies, and mounting hardware are either of economical cold-rolled steel (-20 suffix) or of 300-series stainless steel with sealed stainless steel ball bearings (-21 suffix). -21 heads offer high corrosion resistance and protection should tubing fail . . . and you can flush heads without fear of removing lubricant from the sealed bearings.



Standard heads can be cascaded for multi-channel pumping



Standard Masterflex® pump head



New *Quick-Load* pump head

New *Quick-Load* heads (7020 series) feature a special patented design (U.S. Patent No. 4,138,205) that makes it a snap to load tubing. You just loosen the two retaining nuts, turn the tubing retainer and swing out cover halves, and place the tubing around the rotor assembly. Turn retainer back, swing in cover halves, and tighten nuts to hold tubing secure.

All *Quick-Load* heads are molded of crystal-clear Lexan® polycarbonate. Rotor assembly and lower fastening nut are of 300-series stainless steel; tubing retainer stud, both fastening nuts, and mounting hardware are carbon steel. Rotor assembly rides on two sets of sealed stainless steel ball bearings; rollers ride on similar bearings.

Quick-Load heads are a great convenience if you have to change tubing frequently; they cannot, however, be used in cascading arrangement for multi-channel pumping.

MASTERFLEX® PUMP HEADS AND TUBING

Pump heads		Standard Masterflex* pump heads						*Quick-Load* Masterflex* pump heads			
Rotor materials and bearings		7013 series	7014 series	7016 series	7015 series	7017 series	7018 series	Single tubing size size	*Triple tubing size (Accommodates 3 tubing sizes, one size at a time)		
									Size A	Size B	Size C
Cold-rolled steel	Cat. no.	7013-20	7014-20	7016-20	7015-20	7017-20	7018-20	*Quick-Load* heads are available only in stainless steel with sealed ball bearings			
Stainless steel (sealed ball bearings)	Cat. no.	7013-21	7014-21	7016-21	7015-21	7017-21	7018-21	7020-20	7020-40		

Flow specifications

Data given below are approximate, determined under the following conditions: inlet 0 psig; outlet 0.5 psig; 22°C water circulant; inlet and outlet tubing each about 2 feet long. Flow at maximum continuous head pressure is about 90% of flow at 0 head pressure. For the 7015 series standard heads and the 7020-20 *Quick-Load* head, flow is somewhat less than 90% at continuous head pressure.

Max flow rate at 600 rpm, ml/min	36	126	480	1000	1680	2280	1000	36	126	480
Max flow rate at 100 rpm, ml/min	6	21	80	167	280	380	167	6	21	80
Flow range 6-600 rpm, ml/min	0.36-36	1.26-126	4.8-480	10-1000	16.8-1680	22.8-2280	10-1000	0.36-36	1.26-126	4.8-480
Flow range 1-100 rpm, ml/min	0.06-6	0.21-21	0.80-80	1.67-167	2.80-280	3.80-380	1.67-167	0.06-6	0.21-21	0.80-80
Flow rate, ml per revolution	0.06 ml	0.21 ml	0.80 ml	1.67 ml	2.80 ml	3.80 ml	1.67 ml	0.06 ml	0.21 ml	0.80 ml
Max continuous head pressure	20 psi	20 psi	20 psi	25 psi	20 psi	20 psi	25 psi	20 psi	20 psi	20 psi
Max intermittent head pressure	35 psi	35 psi	35 psi	40 psi	35 psi	35 psi	40 psi	35 psi	35 psi	35 psi
Maximum vacuum	24" Hg	24" Hg	24" Hg	24" Hg	24" Hg	12" Hg	24" Hg	24" Hg	24" Hg	24" Hg

Precision-extruded close-tolerance *MASTERFLEX*® tubing

Only Masterflex tubing will work properly with Masterflex tubing pumps. The tubing listed here has been made to stringent dimensions, subject to quality control checking by an optical comparator, for compatibility with Masterflex pump heads. The use of any other tubing than that listed here may result in tubing failure, tubing slippage, decreased pressure or vacuum efficiency, and/or other malfunctions. *Before ordering tubing,* consult the *Tubing applications suitability table* below as a general guide to finding the appropriate tubing for your needs.

pump ne The use of any other tubing than that listed propriate tubir our needs.

Inside dimensions		0.031"	0.065"	0.125"	0.192"	0.255"	0.313"	0.192"	0.031"	0.065"	0.125"
Outside dimensions		0.162"	0.194"	0.251"	0.392"	0.390"	0.439"	0.392"	0.162"	0.194"	0.251"
Tygon® (R-3603) tubing	Cat. no.	6408-41	6408-43	6408-02	6408-45	6408-06	6408-09	6408-45	6408-41	6408-43	6408-02
Tygon® special tubing	Cat. no.	6401-41	6401-43	6401-44	6401-45	6401-47	6401-48	6401-45	6401-41	6401-43	6401-44
Tygon® food tubing	Cat. no.	6419-41	6419-43	6419-02	6419-45	6419-06	6419-09	6419-45	6419-41	6419-43	6419-02
Silicone tubing	Cat. no.	6411-41	6411-43	6411-02	6411-45	6411-47	6411-09	6411-45	6411-41	6411-43	6411-02
Viton® tubing	Cat. no.	6412-41	6412-43	6412-44	6412-45	6412-47	6412-48	6412-45	6412-41	6412-43	6412-44

Tubing applications suitability table

Ratings given below are general and based on average applications. Cole-Parmer assumes no responsibility for their use in specific applications. Always subject a sample of the tubing to an immersion test in the fluid to be pumped, particularly if you're working with hazardous material, before ordering tubing in quantity. Call or write our Pump Applications Dept. for additional assistance if needed.

Three kinds of low-cost Tygon tubing are offered for a range of applications. Viton® tubing offers exceptional chemical resistance, but has a short life. Silicone tubing is good for food and biochemical uses; it has the widest temperature range and the longest life . . . it stands up to the squeezing action of the pump head for up to 450 hours at 200 rpm.

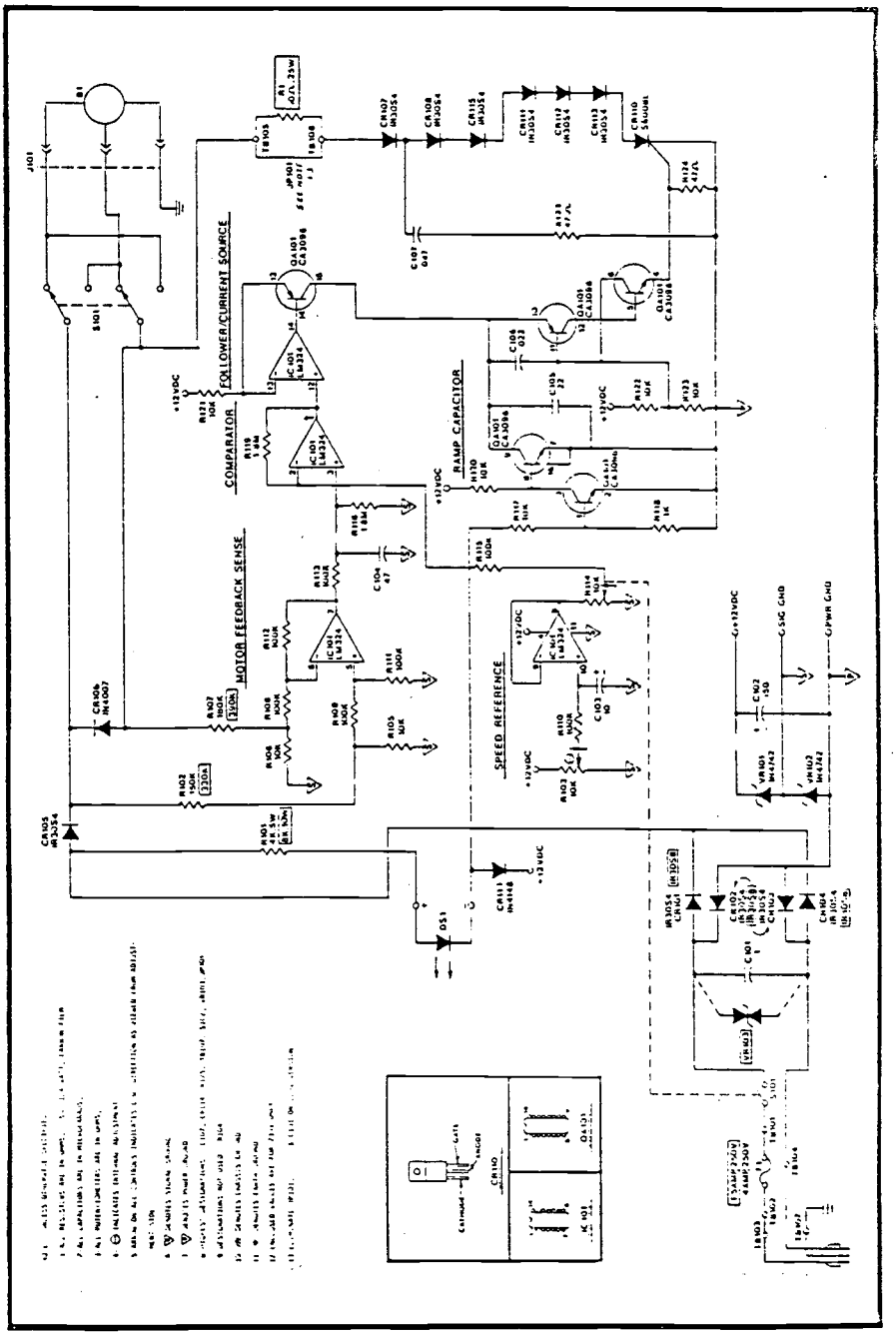
Legend: "E" = Excellent, "G" = Good, "F" = Fair, "P" = Poor, "N" = Not recommended; "A" = Autoclavable

Tubing series no	Type	Application suitability: Pressure	Vacuum	Corrosives: Acids	Corrosives: Bases	Solvents: General	Solvents: Highly Active	Temperature: High	Temperature: Low	Temperature: Extra Low	Special uses	Tubing life* at 550 rpm	Temperature limits (°F): Min	Max
6408	Tygon® (R-3603)	G	G	G	G	G	F	F	G	N	—	50 hrs	−20	+165
6401	Tygon® special	G	G	F	P	G	F	F	F	N	Hydrocarbons[1]	50 hrs	+10	+180
6419	Tygon® food	G	G	—	—	—	—	F,A	F	N	Food[2]	40 hrs	0	+180
6411	Silicone	G	E	F	F	F	F	E,A	E	E	Food, bio./pharm.[2]	150 hrs[3]	−80	+500
6412	Viton®	E	F	E	E	E	G	E	F	N	—	30 hrs	−10	+400

1) Especially suited for gasoline, fuels, oils, and lubricants
2) Meets USDA and FDA material/ingredient requirements
3) Except for 6411-09, which has a 70-hour life at 550 rpm
4) Approximate life in pump head, subjected to the stresses of peristaltic action. Tubing life is inversely proportional to pump speed, halving the speed should double the life

Tygon—Reg TM U S Stoneware
Viton—Reg TM E I DuPont de Nemours and Co
Masterflex—Reg TM Cole-Parmer Instrument Co

Variable Speed Masterflex Schematic



Controller Parts List No. 1

115 V AC 50-60 Hz. (7553, 7553-10)

SYMBOL	PART NO.	ITEM
F1	B-1115-27	FUSE 4AMP
DS101	A-2527-2	LED
PC1	E-1275	P.C. BOARD ASS'Y
R101	B-1113-109	RESISTOR 4K, 5W
R102	B-1113-245	RESISTOR 150K, 1/4W
R105,6,117,120-123	B-1113-149	RESISTOR 10K, 1/4W
R107	B-1113-261	RESISTOR 180K, 1/4W
R118	B-1113-151	RESISTOR 1K, 1/4W
R108-113,115	B-1113-226	RESISTOR 100K, 1/4W
R116,119	B-1113-232	RESISTOR 1.8M, 1/4W
R124,125	B-1113-176	RESISTOR 47 OHM, 1/4W
CR101-5, 107-8, 111, 112, 113, 115	B-1119-7	DIODE
CR106	B-1119-2	DIODE
VR101, 102	B-1126-7	DIODE-ZENER
CR114	B-1119-8	DIODE
IC101	A-2360	CIRCUIT-INTEGRATED
QA101	B-1823	TRANSISTOR ARRAY
C101	B-1114-17	CAPACITOR .1UF, 250V
C102	B-1114-64	CAPACITOR 150UF, 35V
C103	B-1114-65	CAPACITOR 10UF, 25V
C104	B-1114-66	CAPACITOR .47UF, 100V
C105	B-1114-52	CAPACITOR .22UF, 100V
C106	B-1114-67	CAPACITOR .022UF, 250V
C107	B-1114-69	CAPACITOR .047UF, 630V
R103	B-1117-57	TRIM-POT 10K
CR110	B-1820	SCR 8A, 600V
S101	B-1117-74	POT w/SWITCH 10K
S102	B-1084-46	SWITCH TOGGLE DPDT

Controller Parts List No. 2

230 V AC 50-60 Hz. (7554, 7554-10)

SYMBOL	PART NO.	ITEM
F1	B-1115-32	FUSE 1.5AMP
DS101	A-2527-2	LED
S101	B-1117-74	POT w/SWITCH 10K
S102	B-1084-46	SWITCH-TOGGLE DPDT
PC2	E-1276	P.C. BOARD ASS'Y
R101	B-1113-263	RESISTOR 8K, 10W
R102	B-1113-264	RESISTOR 330K, 1/4W
R105-6, 117, 120-123	B-1113-149	RESISTOR 10K, 1/4W
R107	B-1113-246	RESISTOR 390K, 1/4W
R118	B-1113-151	RESISTOR 1K, 1/4W
R108-113, 115	B-1113-226	RESISTOR 100K, 1/4W
R116, 119	B-1113-232	RESISTOR 1.8M, 1/4W
R124, 125	B-1113-176	RESISTOR 47 OHMS, 1/4W
CR101,2,3,4	B-1119-10	DIODE-BRIDGE
CR105,7,8,11,12,13,15	B-1119-7	DIODE
CR106	B-1119-2	DIODE
VR101, 2	B-1126-7	DIODE ZENER
CR114	B-1119-8	DIODE
IC101	A-2360	CIRCUIT-INTEGRATED
QA101	B-1823	TRANSISTOR ARRAY
C102	B-1114-64	CAPACITOR 150UF, 35V
C103	B-1114-65	CAPACITOR 10UF, 25V
C104	B-1114-66	CAPACITOR .47UF, 100V
C105	B-1114-52	CAPACITOR .22UF, 100V
C106	B-1114-67	CAPACITOR .022UF, 250V
C107	B-1114-69	CAPACITOR .047UF, 630V
R103	B-1117-57	TRIM-POTENTIOMETER 10K
VR103	A-2122-3	VARISTOR-METAL OXIDE
CR110	B-1820	SCR 8A, 600V
R1	B-1113-265	RESISTOR-POWER 10 OHM, 25W

Motor Repair Parts

ITEM	PART NO.	DRIVE
MOTOR BRUSHES (set of 2)	A-2543-CR	7553, 7553-10, 7554, 7554-10
BRUSH CAP	A-2542-CR	ALL DRIVES NOTED ABOVE
GEAR CASE GASKET	B-1467	ALL DRIVES
ARMATURE 115V	A-2544-CR	7553
ARMATURE 115V	A-2544-CR	7553-10
ARMATURE 230V	A-2545-CR	7554
ARMATURE 230V	A-2545-CR	7554-10
REPLACEMENT GEAR KIT	7553-06	7553, 7554
REPLACEMENT GEAR KIT	7553-08	7553-10, 7554-10
NEEDLE BEARING	A-1164	7553-10, 7554-10
OILITE BUSHING	A-2497	7553, 7554

Masterflex Pump Replacement Parts

(metal parts are plated steel)

STANDARD PUMP HEAD	PLASTIC PUMP HEAD SECTION	ROTOR ASSEMBLY
7013-20	A-1106-2	B-1289-1
7014-20	A-1106-3	B-1289-1
7016-20	A-1106-5	B-1289-1
7015-20	A-1106-1	B-1289-2
7017-20	A-1106-4	B-1289-1
7018-20	A-1106-6	B-1289-1

All rotor assemblies use teflon thrust washers, A-1184.

Masterflex Pump Replacement Parts

(metal parts are stainless steel)

STANDARD PUMP HEAD	PLASTIC PUMP HEAD SECTION	ROTOR ASSEMBLY
7013-21	A-1400-1	B-1291-1
7014-21	A-1400-2	B-1291-1
7016-21	A-1400-5	B-1291-1
7015-21	A-1400-3	B-1291-2
7017-21	A-1400-4	B-1291-1
7018-21	A-1400-6	B-1291-1

All rotor assemblies use teflon thrust washers, A-1184.

Masterflex Pump Replacement Parts

(metal parts are stainless steel)

QUICK LOAD PUMP HEAD		
PUMP HEAD NO.	7020-20	7020-40
PART DESCRIPTION	PART NO.	PART NO.
ASSEMBLY PUMP HOUSING	D-1569	D-1569
ASSEMBLY ROTOR	D-1624-1	D-1624-2
REAR TUBING RETAINER	B-1703	B-1701*
FRONT TUBING RETAINER	A-2489	A-2488*
PLASTIC REACTION ARM, R.H.	E-1222	E-1222
PLASTIC REACTION ARM, L.H.	E-1221	E-1221
WAVE WASHER	A-2480	A-2480
MOUNTING SCREW (PLATED)	A-2386-12	A-2386-12
CLAMP KNOB (PLATED)	A-2383-12	A-2383-12
REAR TUBING RETAINER		B-1702**
FRONT TUBING RETAINER		A-2490**

*For the -41 tubing

**For the -43, -02 and -44 tubing

MAINTENANCE

The speed control circuit has solid state components which do not require servicing. A tubing rupture may result in a motor overload which could cause some electrical parts to fail.

Exact motor brush and commutator life will depend on the speed and the number of pump heads. Brushes should be inspected every six months or 2000 hours whichever occurs first. Replace when less than 0.300" long. The commutator should be periodically inspected and cleaned if necessary. If preventive maintenance is not performed, excessive commutator wear or 'bridging' between commutator segments will cause excessive current through the controller circuit.

WARRANTY

The Cole-Parmer Instrument Company warrants the product to be free from defects in material and workmanship for a period of six months. If repair or adjustment is necessary and has not been the result of abuse or misuse within the six month period, please return, freight prepaid, and correction of the defect will be made without charge (see note on return of items).

For your protection, items being returned must be *carefully packed* to prevent damage in shipment and *insured* against possible damage or loss. Cole-Parmer will not be responsible for damage resulting from careless or insufficient packing.

Out of warranty products will be repaired for a nominal charge.

RETURN OF ITEMS

Authorization must be obtained from our Customer Service Department before returning items for any reason. When applying for authorization, please include data regarding the reason the items are to be returned. A 15% restocking charge will be made on all unauthorized returns.

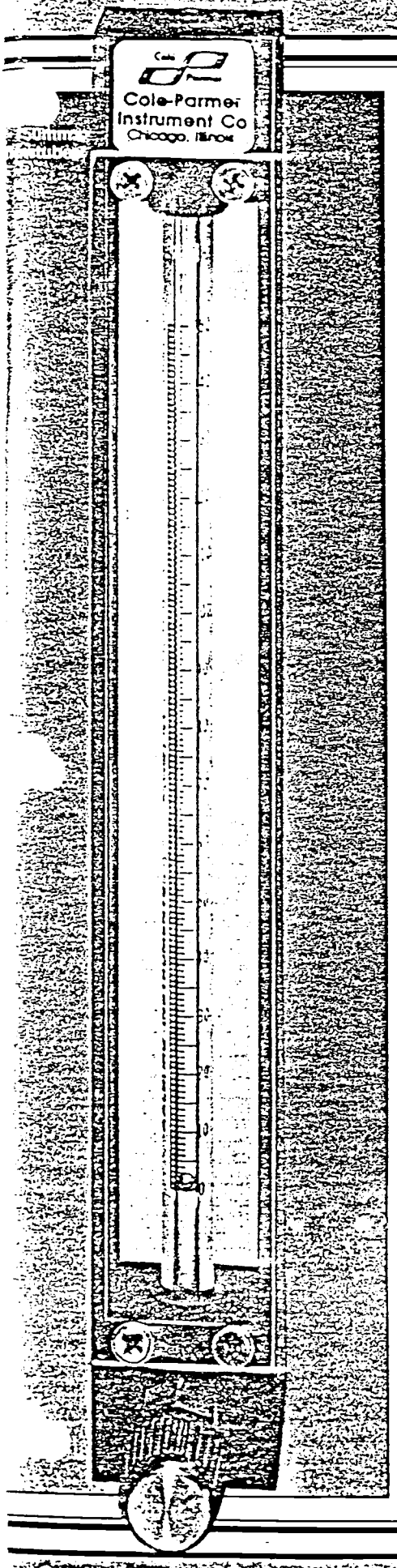
TECHNICAL ASSISTANCE

Technical information and advice on the use of the products in specific applications may be obtained. Modifications can be made to adapt the unit to special customer applications. Contact the Engineering Department for information.

The Cole-Parmer Instrument Company reserves the right to make improvements in design, construction and appearance of our products without notice.

APPENDIX D-5

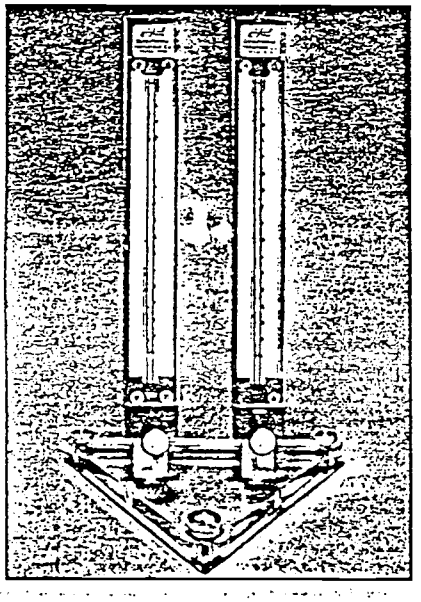
ROTAMETER SPECIFICATIONS



Ordering information

Flowmeters with 65mm flowtubes						
Aluminum frame		316 stainless steel frame		Max flow rate*		
Cat. no.	Price	Cat. no.	Price	Air ml/min	Water ml/min	Float material
K-3216-00	$37.40	K-3218-01	$90.00	6.9	0.14	Glass
K-3216-02	37.40	K-3218-03	90.00	20.8	0.33	316 stainless steel
K-3216-04	37.40	K-3218-05	90.00	52	0.61	Glass
K-3216-06	37.40	K-3218-07	90.00	165	2.50	316 stainless steel
K-3216-08	37.40	K-3218-09	90.00	130	1.6	Glass
K-3216-10	37.40	K-3218-11	90.00	329	8.8	316 stainless steel
K-3216-12	37.40	K-3218-13	90.00	221	2.98	Glass
K-3216-14	37.40	K-3218-15	90.00	516	11.20	316 stainless steel
K-3216-16	37.40	K-3218-17	90.00	1163	24	Glass
K-3216-18	37.40	K-3218-19	90.00	2680	72	316 stainless steel
K-3216-20	37.40	K-3218-21	90.00	2035	44	Glass
K-3216-22	37.40	K-3218-23	90.00	3942	122	316 stainless steel
K-3216-24	37.40	K-3218-25	90.00	2806	60	Glass
K-3216-26	37.40	K-3218-27	90.00	5284	152	316 stainless steel
K-3216-28	37.40	K-3218-29	90.00	7241	134	Glass
K-3216-30	37.40	K-3218-31	90.00	12142	**	316 stainless steel
K-3216-32	37.40	K-3218-33	90.00	14397	**	Glass
K-3216-34	37.40	K-3218-35	90.00	23883	**	316 stainless steel
K-3216-36	37.40	K-3218-37	90.00	25300	570	Glass
K-3216-38	37.40	K-3218-39	90.00	42309	1250	316 stainless steel
K-3216-40	44.65	K-3218-41	97.25	67610	2100	Carboloy
Flowmeters with 150mm flowtubes						
K-3217-00	60.00	K-3219-01	118.00	27	0.29	Glass
K-3217-02	60.00	K-3219-03	118.00	68.5	1.08	316 stainless steel
K-3217-04	60.00	K-3219-05	118.00	51	0.61	Glass
K-3217-06	60.00	K-3219-07	118.00	148	2.50	316 stainless steel
K-3217-08	60.00	K-3219-09	118.00	90.9	1.02	Glass
K-3217-10	60.00	K-3219-11	118.00	268.0	4.96	316 stainless steel
K-3217-12	60.00	K-3219-13	118.00	378	5.8	Glass
K-3217-14	60.00	K-3219-15	118.00	832	20.8	316 stainless steel
K-3217-16	60.00	K-3219-17	118.00	845	17.8	Glass
K-3217-18	60.00	K-3219-19	118.00	1694	48.9	316 stainless steel
K-3217-20	60.00	K-3219-21	118.00	2330	53.2	Glass
K-3217-22	60.00	K-3219-23	118.00	4640	133.4	316 stainless steel
K-3217-24	60.00	K-3219-25	118.00	3861	88.0	Glass
K-3217-26	60.00	K-3219-27	~~118.00~~ 140	7600	221.0	316 stainless steel
K-3217-28	60.00	K-3219-29	118.00	8732	206	Glass
K-3217-30	60.00	K-3219-31	118.00	16614	502	316 stainless steel
K-3217-32	60.00	K-3219-33	118.00	23222	564	Glass
K-3217-34	60.00	K-3219-35	118.00	43424	1323	316 stainless steel
K-3217-36	67.25	K-3219-37	125.25	60888	1944	Carboloy

*Minimum flow rate is approximately 10% of the maximum figure. **Not recommended for use with water.



Tripod bases

Bench mount up to 3 flowmeters in the lab ... any combination of 65mm and 150mm models. Three levelling screws and spirit level are built into acrylic base.

Cat. no.	No. of flowmeters	Price
K-3226-10	1	$22.50
K-3226-20	1 or 2	25.00
K-3226-30	1, 2, or 3	27.50

Pipe-to-tube adapters

Polyethylene straight adapters

Cat. no.	MIPT	Tubing ID	Price/12
K-6450-10	1/8"	3/16"	$3.12
K-6450-11	1/8"	1/4"	3.24
K-6450-12	1/8"	3/8"	3.36

Polyethylene elbow adapters

Cat. no.	MIPT	Tubing ID	Price/12
K-6451-10	1/8"	3/16"	$6.24
K-6451-20	1/8"	1/4"	6.36
K-6451-21	1/8"	3/8"	6.48

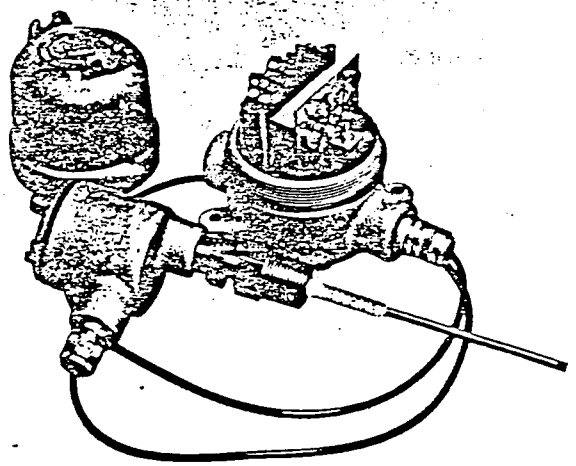
APPENDIX D-6

LEVEL SENSOR SPECIFICATIONS

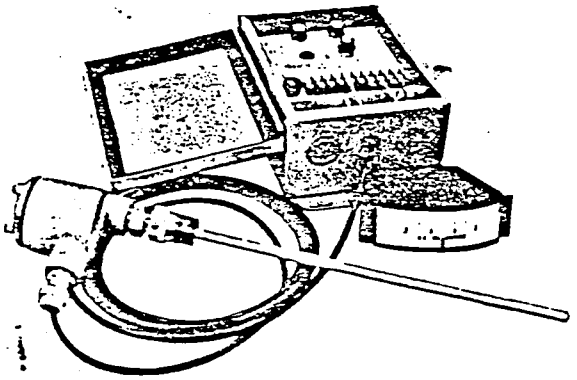
CAP-LEVEL™

series 600 capacitance level controls

Point Control — Integral



Point Control — Remote



Continuous Control

BINDICATOR®
A LEVEL CONTROL COMPANY

introduction: Point and continuous capacitance type level controls offered by Bindicator provide precise, reliable and economical level control for both non-coating liquid and granular materials.

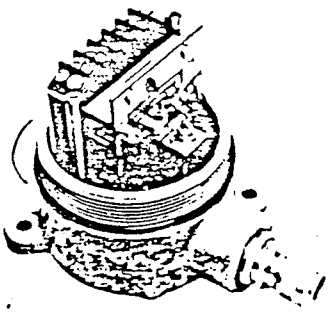
A leader in the level control field for more than 35 years, Bindicator's design, construction and installation experience assures you of receiving the best possible level control for your application.

application: Utilizing a combination of point and continuous capacitance level controls, it is possible to achieve any or all of the following: High or low level control and/or alarm; automation of vessel loading and emptying; inventory monitoring; indication of a desired vessel condition; sensing of material presence for a wide variety of materials and vessel configurations. This functional versatility makes the capacitance type of level control an extremely useful tool for today's complex industrial society.

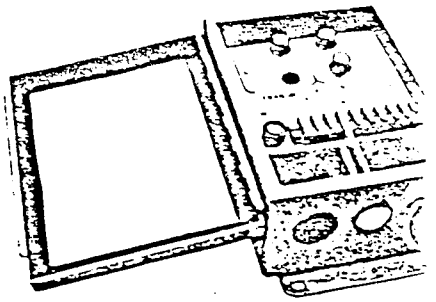
Food storage and processing, aggregate handling, mining and metallurgy, and chemical and petroleum processing are only a few of the areas in which Bindicator capacitance level controls are providing time and cost savings in industrial production procedures.

operational theory: A basic capacitance level control consists of a vessel, the material contained therein, a sensing probe, and an electronic unit. This precision level control instrumentation operates by measuring the electrical capacitance that exists between the probe, which is being driven by a low power electrical signal, and the vessel. The magnitude of this vessel capacitance is dependent upon the level of material between these two elements. Changes in the material level thus cause changes in the vessel capacitance which is monitored by a precision bridge circuit in the electronic unit. For a point control, these capacitance changes cause relay activation; on a continuous unit, they provide an electrical signal proportional to the level of material in the vessel.

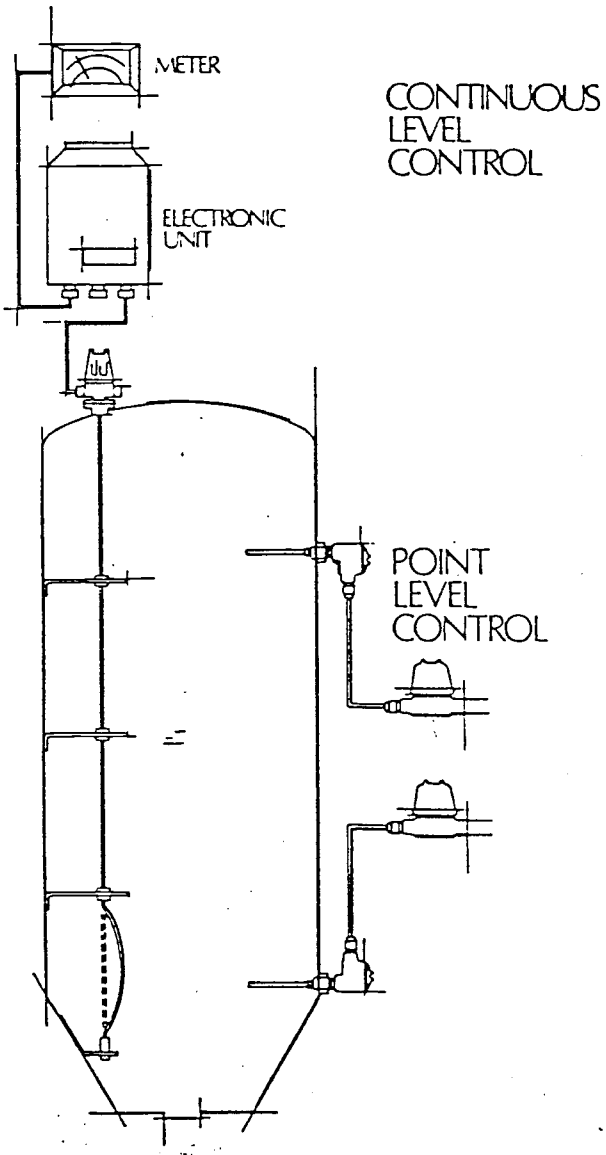
electronics package:



Point Control
Model 600



Continuous Control
Model 660



BINDICATOR®
A LEVEL CONTROL COMPANY

BASIC ELECTRONIC UNITS:

description:

Point—Model 600 & 610

Available remote or integral to probe assembly
Compact size
All silicon transistor circuitry
No periodic recalibration
Rugged
High or low level fail-safe (field convertible)
Explosion proof:
- Class 1, Div. 1 & 2, Groups C & D
- Class 2, Div. 1 & 2, Groups E, F, & G

Use: Conductive or non-conductive liquids and granular materials

Continuous—Model 660

No electronics at probe
No periodic recalibration
Direct or reverse acting (field convertible)
Non-interacting span and zero
Field convertible output
All silicon transistor circuitry
Explosion proof options:
- Class 1, Div. 1 & 2, Group C & D
- Class 2, Div. 1 & 2, Groups E, F, & G

Use: Conducting or non-conducting liquids, dry granular materials, interface

electrical specifications:

Point—Model 600 & 610

Line Voltage: 115 ± 20VAC, 50/60 Hz
Power: 7 watts
Line Voltage Sensitivity: ± 0.3 pf for ± 20VAC
Ambient Temperature for Electronic Unit:
—40 to +160°F.
Temperature Sensitivity: 0.3 pf for 50°F.
Output: 5A relay at 115VAC non-inductive
Input Sensitivity: 0.4 pf

Continuous—Model 660

Line Voltage: 115 ± 20VAC, 50/60 Hz
Power: 7 watts
Line Voltage Sensitivity: ± 0.5% for ± 20VAC
Ambient Temperature for Electronic Unit:
—40 to + 160°F.
Temperature Sensitivity: 0.02% per °F. or .08 pf (whichever is larger)
Span: .25 to 5000 pf
Output and Max. Load Resistance:

1 - 5 ma	6000 ohms
4 - 20 ma	1500 ohms
10 - 50 ma	600 ohms

Load Resistance Sensitivity: 0.1% from zero to full load
Output Linearity: ± 1.0%
Output Response Time: 150 μsec.

APPENDIX D-7

PCA CONCRETE PROTECTIVE TREATMENTS GUIDANCE DOCUMENT

Effects of Substances on Concrete and Guide to Protective Treatments

Quality concrete must be assumed in any discussion on how various substances affect concrete. In general, achievement of adequate strength and sufficiently low permeability to withstand many exposures requires proper proportioning, placing, and curing. Certain fundamental principles by which the quality of concrete can be controlled are well established:

- *Low water-cement ratio*—not to exceed 0.49 by weight.
- *Minimum cement content*—564 lb per cubic yard (335 kg/m^3).
- *Suitable cement type*— such as portland cement low in tricalcium aluminate, C_3A, to reduce or prevent attack by some chemicals that react with C_3A, notably sulfates.
- *Adequate air entrainment*—the amount dependent on maximum aggregate size.
- *Suitable workability*—avoiding mixes so harsh and stiff that honeycomb occurs, and those so fluid that water rises to the surface. Slump should be 2-4 in. (50-100 mm).
- *Thorough mixing*—until all concrete is uniform in appearance, with all materials evenly distributed.
- *Proper placing and consolidation*—filling all corners and angles of forms without segregation of materials. Where possible, construction joints should be avoided.
- *Adequate curing*—supplying additional moisture to the concrete during the early hardening period or covering concrete with water-retaining materials. (Rapid evaporation of moisture from the concrete surface soon after it is placed may cause plastic shrinkage cracking.) *Curing compounds must not be used on surfaces that are to receive protective treatment.* Concrete should be kept moist and above 50°F (10°C) for at least the first week, but longer curing periods usually increase resistance to corrosive substances. Concrete should not be subjected to hydrostatic pressure during this period.

Design Considerations

Whenever concrete is to be coated for corrosion protection, the forms should be coated with materials that will not impregnate or bond to the concrete after they have been stripped. Hence, forms coated with form oils or waxes should not be used against surfaces to be coated. Curing membranes that are weakly bonded to the concrete may develop little or no bond to coatings applied over them. If form oils, waxes, or curing membranes are present, they should be removed by acid washing, sandblasting, scarifying, or other such processes.

Where spillage of corrosive substances is likely to occur, a floor should have a slope to drains of at least 2% to facilitate washing.

Many solutions that have no chemical effect on concrete, such as brines and salts, may crystallize upon drying. It is especially important that concrete subject to alternate wetting and drying of such solutions be impervious to them. When free water in concrete is saturated with salts, the salts crystallize in the concrete near the surface during the drying process, sometimes exerting sufficient pressure to cause scaling. Structures exposed to brine solutions and having a free surface of evaporation should therefore be provided with a protective treatment on the side exposed to the solution.

In addition, movement of salts into the concrete may result in corrosion of reinforcing steel. The corrosion reactions form compounds that cause expansion and disruption of the concrete. Significant corrosion of steel in reinforced concrete will occur if (1) sufficient oxygen is available, and (2) the normally passive state of steel in concrete is impaired. Porous concrete or surface cracks permit the penetration of oxygen to the reinforcement. The steel is normally passive because a protective oxide film is formed and maintained on it by the high concentration of hydroxide ions (high pH) in the water solution in concrete. This protective film may be impaired by (1) sufficient lowering of the pH value, as by reaction of carbon dioxide from the air or other sources, or (2) a sufficient concentration of chloride ions in solution. High cement content in high-quality impermeable concrete provides protection against corrosion of reinforcement by producing a high pH value and limiting exposure to the air.

It is important that sufficient concrete coverage be provided for reinforcement where the surface is to be exposed to corrosive substances. Carbon steel bar

supports for reinforcement should not extend to the concrete surface. Deep recesses in the concrete should be provided for form ties, and they should be carefully filled and pointed with mortar.

Acids attack concrete by dissolving both hydrated and unhydrated cement compounds as well as calcareous aggregate. In certain acids and acid solutions it may be impossible to apply an adequate protective treatment to the concrete, and the use of a "sacrificial" calcareous aggregate should be considered. Replacement of siliceous aggregate by limestone or dolomite having a minimum calcium oxide concentration of 50% will aid in neutralizing the acid. The acid will attack the entire exposed surface more uniformly, reducing the rate of attack on the paste and preventing loss of aggregate particles at the surface. The use of calcareous aggregate will also retard expansion resulting from sulfate attack caused by some acid solutions.

The rate of attack on concrete may be directly related to the activity of the aggressive chemical. Solutions of high concentration are generally more corrosive than those of low concentration—but in some cases, the reverse is true. The rate of attack may be altered by the solubility of the reaction products of the particular concrete. Lowering the hydroxide ion concentration generally causes more rapid attack in the concrete. Also, since high temperatures usually accelerate any attack, better protection is required than for normal temperatures.

Surface Preparation

Proper preparation of the concrete surface and good workmanship are essential for the successful application of any protective treatment. Concrete should normally be well cured (28 days to six months, depending on service conditions and coatings used) and dry before the protective coatings are applied. Moisture in the concrete may cause excessive internal vapor pressure that can result in the treatment's blistering and peeling.

Precautions should be taken to eliminate objectionable voids in the surface that might cause pinholes in the coating. Good vibration and placing techniques will reduce the number of these surface imperfections. The concrete surface should be smoothed immediately after removal of forms by applying grout or mortar, or by grinding the surface and then working grout into it. Other surface treatments that have good adhesion to cured concrete, such as latex-modified grouts or mortars, epoxy, or other synthetic resin formulations, can also be used to produce a smooth surface.

It is important to have a firm base free of grease, oil, efflorescence, laitance, dirt, and loose particles. The best method of cleaning the concrete surface depends on job conditions. Dry removal of accumulated dirt and soil is best achieved by scarifying, grinding, or sandblasting, but the dust and dirt produced by these methods may be undesirable. When such dust cannot be tolerated, a liquid-based cleaning technique can be used. There are three stages of wet cleaning: (1) degreasing, (2) acid treatment, and (3) neutralizing to clean and etch thoroughly. Cleaning operations should be performed only under conditions where appropriate safety precautions have been taken.

Degreasing is accomplished by applying a mixture of a cleaner/curing-compound remover (a chlorinated, emulsifiable solvent), an industrial grease remover (a highly alkaline, low-phosphate, biodegradable detergent), and liberal amounts of water. The mixture is used to scrub the concrete surface, repeatedly, if necessary. The surface finally is rinsed and scrubbed with clear water, vacuumed to a damp condition, and then allowed to air-dry.

Acid treatment of the surface involves scrubbing the dry floor with an etching solution (a mild organic acid combined with detergents, emulsifiers, and solvent). After a vacuuming machine picks up any residual material, the concrete surface is then rinsed, scrubbed clean of the acid solution, and dried.

Neutralization of any acid left on the surface is then accomplished by wetting the surface with clear water, sprinkling on a detergent cleaner (highly alkaline, high-phosphate, non-residue-forming detergent), scrubbing, rinsing with water, and vacuuming to a damp condition. The concrete is then rinsed again with clear water, vacuumed damp-dry, and allowed to air-dry before the new surface finish is applied.

Acid treatment is recommended only for cleaning floor surfaces that are to receive a new surface finish. Other wet-cleaning methods include high-pressure water-jet blasting and steam cleaning. Selection of method depends on the type and severity of contamination.

Grinders can be used to remove weak, friable laitance, high spots, and trowel and other marks. Grinding can improve the smoothness and wear-resistance of the floor.

Scarifiers and concrete sanders can remove laitance, paint marks, pitch adhesives, thermoplastic adhesives, smooth the concrete, and produce nonskid surfaces. The machines have hardened-steel cutting wheels that hammer off the surface.

Shotblasting or abrasive blasting removes surface contaminants. Machines with vacuum bags make the operation almost dust-free.

After a concrete surface is cleaned and dried, all residue must be removed. Various industrial vacuum machines are used to remove microdust particles from a prepared surface.

Concrete cast against forms is sometimes so smooth that adhesion of protective coatings becomes difficult. Such surfaces should be acid-etched, sandblasted lightly, or ground with silicon carbide stones to obtain a slightly roughened surface.

Choosing the Treatment

Protective treatments for concrete are available for almost any degree of protection required. Coatings vary widely in composition and performance, and some of the generic classifications given here are so broad that

they can serve only as a guide. *The reader is advised to seek further, more detailed recommendations* from the manufacturer, formulator, producer, or material supplier.*

Every coating is formulated to render a certain performance under specified conditions. Its quality should not be determined solely by the merits of any of its components since it is the proportioning of ingredients that determines performance. Coating performance also depends upon the quality of surface preparation, method and quality of coating application, air conditions during application, and film thickness. Any general discussion of chemical resistance and other properties of coatings must assume optimum formulation and proper use. The producers of the various coatings can provide valuable information on the merits of their products for a particular use and on the proper and safe procedure for application. Many coatings contain solvents that are fire, explosion, or toxic hazards.

Certain materials (thermoplastics) soften at elevated temperatures and may even melt or become ineffective. Various grades of coatings are available for use over a fairly wide temperature range. Where flavor or odor is important, the U.S. Food and Drug Administration or the Food Directorate of Health and Welfare Canada should be consulted regarding materials for use with food ingredients.

The coating thickness required depends on (1) the exposure, whether continuous or intermittent; (2) the resistance of the material to the chemicals involved; and (3) the ability to form a continuous, pinhole-free surface. As a rule, thin coatings are not as durable as heavier coatings and hence are less suitable where there is considerable abrasion.

The more common protective treatments are indicated in the tables (starting on page 7), the numbers and letters corresponding to the descriptions given here. For most substances, several treatments are suggested. They will provide sufficient protection in most cases. When choosing a type of protection, consider the chemical environment, service condition (i.e., splash and spill or immersion), and any mechanical requirements, keeping in mind the consequences of failure and ease of repair.

The information in the tables is only a guide for determining when to consider various coatings for chemical resistance. Where more specific information is required, particularly to determine whether protection is required for large installations, small mortar prisms representative of the concrete to be used can be immersed in the corrosive liquid and evaluated for resistance.** Where continuous service over long periods is desirable, it may be more economical to use the higher-quality means of protection rather than a lower-first-cost treatment that may be less permanent.

Protective Treatments

1. Magnesium fluosilicate or zinc fluosilicate. The treatment consists generally of three applications. Either of the fluosilicates may be used separately, but a mixture of 20% zinc fluosilicate and 80% magnesium fluosilicate appears to give the best results. For the first application, 1 lb (0.45 kg) of the fluosilicate crystals should be dissolved in 1 gal (3.78 L) of water; about 2 lb (0.91 kg) of crystals per gallon of water are used for subsequent applications.

The solution may be applied efficiently with large brushes for vertical surfaces and mops for horizontal surfaces. The surfaces should be allowed to dry between applications (about three or four hours are generally required for absorption, reaction, and drying) Brush and wash the surface with water shortly after the last application has dried to remove incrusted salts that can cause white stains.

Treatment with fluosilicates reduces dusting and hardens the surface by chemical action. It increases resistance to attack from some substances but does not prevent such attack. With poor-quality concrete, the treatment is not effective.

Concrete surfaces to be treated with fluosilicates should not contain integral water-repellent agents because these compounds will prevent penetration of the solution. Hardeners should not be used when paints are to be applied because they result in poor adhesion of many coatings. Also, hardened surfaces are difficult to etch properly.

2. Sodium silicate (commonly called water glass). Commercial sodium silicate is about a 40% solution. It is quite viscous and must be diluted with water to secure penetration, the amount of dilution depending on the quality of the silicate and permeability of the concrete. Silicate of about 42.5 degrees Baumé diluted in proportions of one-quarter part per part of water by volume makes a good solution. Two or three coats should be used. For tanks and similar structures, progressively stronger solutions are often used for the succeeding coats.

Each coat should be allowed to dry thoroughly before the next one is applied. On horizontal surfaces the solution may be liberally poured on and then spread evenly with mops, brooms, or brushes. Scrubbing each coat with stiff fiber brushes or with scrubbing machines and water *after it has hardened* will assist penetration of the succeeding application. The treatment increases resistance to attack from some substances but does not prevent such attack.

3. Drying oils. Two or three coats of linseed oil may be used as a protective treatment; boiled linseed oil dries faster than raw oil and is used more commonly. Linoleic acid, oleic acid, or straight tall oil also can be used. Soybean oil and tung (China wood) oil can be used, but costs of these oils fluctuate widely with the commodities market.

The concrete should be well cured and at least 14 days old before the first application of a drying oil. If this

*These four terms are used interchangeably in this publication.

**Kuenning, William H., *Resistance of Portland Cement Mortar to Chemical Attack—A Progress Report*, Bulletin RX204, Portland Cement Association, 1966.

is not possible, the concrete should be neutralized by applying a solution consisting of 3 oz of zinc chloride and 5 oz of orthophosphoric acid (85% phosphoric acid) per gallon of water (24:40:1000). After it is brushed on the concrete, the solution should be allowed to dry for 48 hours. Any crystals that have formed on the surface should then be removed by light brushing. This solution should not be used on prestressed concrete. Sometimes a magnesium fluosilicate treatment is also applied to harden the surface before the oil treatment.

The oil treatment may be applied with mops, brushes, or spray and the excess removed with a squeegee before the oil gets tacky. It is not wise to build up a heavy surface coating, as penetration of the oil into the surface is desirable. Diluting the oil with turpentine or kerosene to obtain a mixture of equal parts gives better penetration for the first coat; subsequent coatings may be diluted less. Careful heating of the oil to about 150°F (65°C) and hot application to a warm surface also help achieve better penetration. Each coat must dry thoroughly for at least 24 hours before the next application. Drying oils tend to darken concrete.

4. Coumarone-indene. Available in grades from dark brown to colorless, this synthetic resin is soluble in xylol and similar hydrocarbon solvents and should be powdered to aid dissolving. A solution consisting of about 6 lb of coumarone-indene per gallon of xylol with ½ pt of boiled linseed oil (3 kg coumarone-indene per one liter xylol plus 0.02 L boiled linseed oil) makes a good coating. Two or more coats should be applied to fairly dry concrete. The coatings have a tendency to yellow with exposure to sunlight but the yellowing does not seem to affect the protective properties.

Coumarone-indene availability has been decreasing for many years and current substitutes include hydrocarbon resin polymers (hydrocarbon resins) and rosin-based resins.

5. Styrene-butadiene. Styrene-butadiene copolymer resins are available in various medium-strength solvents, some faster drying than others. Three coats are generally recommended, with the first coat thinned for better penetration. Twenty-four hours should elapse between coats, and a delay of 7 days is necessary for thorough drying before the coated surface is placed in service. These coatings tend to yellow with exposure to sunlight.

Decorative styrene-butadiene coatings are widely marketed as latex paints. They are usually not satisfactory for protection against chemical attack because latex paints generally do not form sufficiently impermeable films.

6. Chlorinated rubber. This treatment consists of a trowel-applied mastic of heavy consistency up to ⅛ in. (3 mm) thick, or multiple coats of specially formulated lower-viscosity types can be brushed or sprayed on to a maximum thickness of 10 mils (0.25 mm). An absolute minimum of 5 mils (0.12 mm) (applied in two coats) is recommended for chemical exposure.

In general, concrete should age for two months before this treatment. The concrete may be damp but not wet, as excessive moisture may prevent adequate bonding. It is advisable to thin the first coat, using only the producer's recommended thinner (other thinners may be incompatible). A coating dries tack-free in an hour, but a 24-hour interval is recommended between coats.

The applied coating is odorless, tasteless, and nontoxic after it dries. Its strong solvents, however, may lift and destroy previously painted and aged coatings of oil or alkyd base.

7. Chlorosulfonated polyethylene (Hypalon). Four coats of about 2 mils (0.05 mm) each and an appropriate primer are normally recommended to eliminate pinholes. Thinning is not usually required, but to reduce viscosity for spray application, the producer's recommended thinner should be used up to a limit of 10% of the amount of coating used. Each coat dries dust-free within 10 to 20 minutes and the treatment cures completely in 30 days at 70°F (21°C) and 50% relative humidity. A fill coat of grout or mortar is required since the paint film will not bridge voids in the concrete surface. Moisture on the surface may prevent good adhesion.

These coatings are expensive and must be applied by trained personnel. They are not used where less costly coatings are adequate.

8. Vinyls. Of the vinyls available, polyvinyl chloride, polyvinyl chloride-acetate, and polyvinylidene chloride are the ones used extensively in corrosion control. The resins are soluble only in strong solvents. Due to the high viscosity of the resins, only solutions of low solids content can be made. Multiple coats are therefore required for adequate film thickness. Vinyls should generally be sprayed onto dry surfaces as their fast drying (30 minutes) makes brush application difficult.

Vinyl chloride coatings make good top coatings for vinyl chloride-acetate and others, but do not themselves adhere well directly to concrete.

Polyvinyl acetate latex (waterborne) copolymers are widely available as decorative coatings but, like other latexes, they are usually inferior to solvent-system coatings for chemical resistance. In addition, the vinyl acetate latexes (waterborne emulsions) are sensitive to the free alkalinity of concrete and eventually break down.

9. Bituminous paints, mastics, and enamels. Asphalt or coal tar coatings may be applied cold (paints and mastics in cutback or emulsion form) or hot (mastics and enamels). Two coats are usually applied to surface-dry concrete: a thin priming coat to ensure bond and a thicker finish coat. The priming solution is of thin brushing consistency and should be applied to cover the surface completely; any uncoated spots should be touched up. When the primer has dried to a tacky state, it is ready for the finish coat. Multiple coats should be applied at right angles to each other to ensure continuity and avoid pinholes.

Emulsions are slower drying, more permeable, and less protective than the other coatings. Cutbacks and emulsions, if not completely cured, can impart odor or flavor to materials with which they are in contact. The producer's recommendations on service and application temperatures should be strictly observed.

Bituminous mastics may be applied cold or heated until fluid. Cold mastics are cutbacks or emulsions con-

taining finely powdered siliceous mineral fillers, asbestos fibers, or bitumen-coated fabrics to form a very thick, pasty, fibrous mass. This mass increases the coating's resistance to flowing and sagging at elevated temperatures and to abrasion. Thin mastic layers, about 1/32 in. (1 mm) thick, are troweled on and allowed to dry until the required thickness has been obtained. Hot mastics usually consist of about 15% asphaltic binder, 20% powdered filler, and the remainder sand, graded up to ¼-in. (5-mm) maximum size. They should be poured and troweled into place in 1-in.-thick (25-mm) layers.

Enamels should be melted, stirred, and carefully heated until they reach the required application temperature. If an enamel is heated above the producer's recommended temperature, it should be discarded. If application is delayed, the pot temperature should not be allowed to exceed 375°F (190°C). When fluid, the enamel should be applied quickly over tacky cutback primer since it sets and hardens rapidly.

10. Polyester. These resin coatings are two- or three-part systems consisting of polyester, peroxide catalyst, and sometimes a promoter. The amount of catalyst must be carefully controlled because it affects the rate of hardening. The catalyst and promoter are mixed separately into the polyester. Fillers, glass fabrics, or fibers used to reduce shrinkage and coefficient of expansion compensate for the brittleness of resin and increase strength.

Coatings with a 2- to 3-hour pot life generally cure in 24 to 36 hours at 75°F (24°C). Shorter curing periods require reduced pot life because of high heats of reaction. Coatings are sensitive to changes in temperature and humidity during the curing period. Some coatings can be applied to damp surfaces at temperatures as low as 50°F (10°C). The alkali resistance of some polyesters is limited. It is recommended that trained personnel apply the coatings.

11. Urethane. These coatings may be one- or two-part systems. A one-part system may be moisture cured or oil modified. The coatings that cure by reacting with moisture in the air must be used on dry surfaces to prevent blistering during the curing period. Oil-modified coatings dry by air oxidation and generally have the lowest chemical resistance of the urethane coatings.

Two types of the two-part system are also available: catalyzed and polyol cured. Catalyzed coatings have limited pot life after mixing and cure rapidly. For polyol-cured coatings, the mixture is stirred well and allowed to stand for about one-half hour before use; it should have a pot life of about 8 hours. Polyol-cured coatings are the most chemically resistant of the urethane coatings but require the greatest care in application.

All urethane coatings are easily applied by brush, spray, or roller. For immersion service in water and aqueous solutions, it may be necessary to use a primer and the urethane producer should be consulted. Satisfactory cure rates will be attained at relative humidities of 30% to 90% and temperatures between 50° and 100°F (10° and 38°C). Lower temperatures will retard the rate of cure.

The principal disadvantages of urethane coatings are the very careful surface preparation needed to ensure adhesion and the difficulty in recoating unless the coating is sanded. Multiple coats should be used and an inert filler added if air voids are present on the concrete surface (the coatings are unable to span air voids).

12. Epoxy. These coatings are generally a two-package system consisting of epoxy resin—which may be formulated with flexibilizers, extenders, diluents, and fillers—and a curing agent. The coating properties are dependent on the type and amount of curing agent used. The common curing agents suitable for room-temperature curing are amines, polyamines, amine adducts, polyamides, polysulfides, and tertiary amines.

The single-package coatings are epoxy esters that are generally inferior to the two-package epoxies in chemical resistance. They require an alkali-resistant primer and are not recommended for immersion service. Some epoxy formulations are 100% solids and others are solution coatings. The formulator's recommendations should be followed in selecting the right system for the protection needed.

It is also desirable to follow the formulator's recommendations for the best application procedures, temperatures, and allowable working life. Generally, three coats must be applied to eliminate pinholes; glass flake may also be used to bridge pinholes. Contact with epoxy resins or hardeners can cause skin irritation or allergic reactions, and proper protection, as recommended by the manufacturer, is necessary.

Epoxy liners may be formed with reinforcement such as woven fabrics, mats, or chopped glass fiber. For example, on concrete that may expand or contract significantly due to temperature or moisture changes, an isolation layer of two-component polysulfide joint sealant of the self-leveling type is troweled over the surface to form a 1/32-in.-thick (1-mm) layer of synthetic rubber. As soon as the rubber has cured, the epoxy coating is applied with a roller to a film thickness of 10 mils (0.25 mm). Then fiberglass cloth is spread over the wet epoxy coating and pressed into it. A second epoxy coating is applied immediately to embed the fiberglass.

There are epoxy systems that cure at temperatures of 40°F (5°C) or less, bond to damp surfaces, and will cure even if flooded with water immediately after application.

13. Neoprene. These coatings may be one- or two-part systems. The one-part system is used as a thinner film than the two-part and generally has a lower chemical resistance. It cures slowly at room temperature and some curing agents may limit its shelf life. The two-part system may require a holding period between mixing and application.

To allow evaporation of water from the concrete, application of either system should not begin for at least 10 days after removal of the forms. Some coatings require primers while others are self-priming. Adhesion is often improved by application of a diluted first coat to increase penetration of the surface. Each coat should be sufficiently solvent-dry before the next application; however, if it becomes too fully cured, it may swell and lose adhesion. Three coats, 2 to 3 mils (0.025 to 0.038 mm) each, are normally recommended to eliminate the

possibility of pinholes. For immersion service, minimum dry thickness should be 20 mils (0.5 mm).

14. Polysulfide. These coatings may be one- or two-part systems. They do not harden with age and they remain rubbery over a broad temperature range. Thick coats of 20 to 25 mils (0.5 to 0.62 mm) can be applied at one time. For the one-part system, atmospheric moisture serves as the curing agent; when humidities are low, curing can be hastened by spraying with a fine water mist. The two-part system usually has a pot life of 30 to 45 minutes and becomes tack-free overnight.

15. Coal tar-epoxy coatings are classified in three main types according to epoxy resin content: high-resin coatings for dry thicknesses of 15 mils (0.38 mm); medium-resin coatings for integral linings of concrete pipe; and low-resin coatings for building nonsagging barriers up to 40 mils (1 mm) thick. The first type requires a special primer and its thickness is achieved in two coats. The other types do not require primers and may be applied in a single coat, but they require a relatively long cure time. Some coal tar-epoxy resin coatings are catalytically cured with a hardener or with both hardener and catalyst.

Coal tar-epoxy coatings are a two-package system. A combination of coal tar, filler, solvent, and epoxy resin may be in one package and the curing agent (commonly amine, polyamine, amine adduct, polyamide, or tertiary amine) in the other. These two packages are usually mixed in a ratio of 20:1 or 10:1, but the ratio may be lower. The coal tar, filler, solvent, and curing agent may also be blended together to make up one package and the epoxy resin kept separate for the other package. These two packages are generally mixed in a ratio of 3:1. The packages must be proportioned correctly to secure proper cure and chemical resistance. Storage life of the blends can vary from six months to two years, depending on formulation.

It is important that the two packages be thoroughly mixed, and power agitation is strongly recommended. Mixing small quantities is not advisable. Insufficient mixing will be revealed only after the coating has cured. For some coatings, a one-half-hour waiting period between mixing and application is desired. Pot life is generally 3 to 4 hours at 70°F (21°C), but it may vary from several minutes to 8 hours, depending on solvent content and formulation.

Some coal tar-epoxy coatings should not be applied at temperatures below 50°F (10°C), or when there is danger of their becoming wet within 24 hours of application. However, there is a coal tar epoxy that can be applied at temperatures lower than 40°F (5°C) that will not be harmed by becoming wet immediately after application and can be recoated even after several weeks. Spray applications generally result in better coverage. However, the sides of a short, stiff bristle brush or a long-nap roller may be used. The second coat should be applied within 48 hours to prevent adhesion problems between coats. If the first coat dries at air temperatures above 75°F (24°C), the producer's maximum recommended time between coats must be observed. These coatings should not be put into service until a minimum of 5 days' curing time has elapsed.

16. Chemical-resistant masonry units and mortars. Three basic types of chemical-resistant masonry units are available: Type H brick, generally fire clay; Type L brick, generally shale; and carbon and graphite brick, intended for use where additional chemical resistance is required. Types H and L brick should conform to Standard Specifications for Chemical-Resistant Masonry Units (ASTM C279).

Brick thickness generally varies from 1¼ to 3¾ in (30 to 100 mm), depending upon severity of service conditions. Brick surfaces should be scored or wire cut (matte texture). The brick must, of course, be laid in mortar that is also chemical resistant.

The chemical resistance of mortars may be evaluated by the Standard Test Method for Chemical Resistance of Mortars (ASTM C267). The more commonly used chemical-resistant mortars *may also be used alone*, without masonry units, to form thick coatings, usually applied by trowel. These mortars are:

a. *Asphaltic and bituminous mortars*—for use over a limited range of low temperatures. Some are sand-filled, others are not. They may be applied either as mastics that depend upon evaporation of solvent or as hot-melt compounds.

b. *Epoxy resin mortars*—two- or three-part systems with either amine or polyamide curing agents. They should conform to Standard Specifications for Chemical-Resistant Resin Mortars (ASTM C395) or Standard Specification for Resin Chemical-Resistant Grouts (ASTM C658). For instructions on their use, see the Standard Recommended Practice for Use of Chemical-Resistant Resin Mortars (ASTM C399).

c. *Furan resin mortars*—should conform to ASTM C395 or C658. They require a primer to ensure satisfactory adhesion to concrete. For their use, see ASTM C399.

d. *Hydraulic cement mortars*—For instructions on their use, see the Standard Practice for Use of Hydraulic Cement Mortars in Chemical-Resistant Masonry (ASTM C398).

e. *Phenolic resin mortars*—should conform to ASTM C395. For instructions on their use, see ASTM C399.

f. *Polyester resin mortars*—should conform to ASTM C395. Their resistance to strong chemicals is limited, but they will withstand mildy oxidizing solutions such as bleaches. For instruction on their use, see ASTM C399.

g. *Silicate mortars*—should conform to Standard Specifications for Chemically Setting Silicate and Silica Chemical-Resistant Mortars (ASTM C466). For instructions on their use, see the Standard Practice for Use of Chemically Setting Chemical-Resistant Silicate and Silica Mortars (ASTM C397).

h. *Sulfur mortars*—should conform to Standard Specifications for Chemical-Resistant Sulfur Mortar (ASTM C287). For instructions on their use, see the Standard Recommended Practice for Use of Chemical-Resistant Sulfur Mortars (ASTM C386).

A bed of mortar and an impervious membrane lining are usually placed between the masonry lining and the concrete. Rubber and vinyl sheets or properly primed

and hot-applied ⅜-in.-thick (10-mm) asphaltic materials, both plain and glass cloth reinforced, are preferred for the membrane lining, depending on the corrosive substance. The primer should conform to Standard Specifications for Primer for Use with Asphalt in Dampproofing and Waterproofing (ASTM D41), except that the asphalt content should not be less than 35% by weight. Floor slabs that are to receive a masonry lining should have a smooth wood-float finish. A slab having a steel-trowel finish may be too smooth for adhesion of the asphaltic membrane.

17. **Sheet rubber.** Soft natural and synthetic rubber sheets ⅛ to ½ in. (3 to 12 mm) thick may be cemented to concrete with special adhesives. Sometimes two layers of soft rubber are used as a base, with a single layer of hard rubber over them.

Chemical-resistant synthetics available as sheeting are neoprene, polyvinylidene chloride-acrylonitrile, plasticized polyvinyl chloride, polyisobutylene, butyl, nitrile, polysulfide, and chlorosulfonated polyethylene rubbers.

18. **Resin sheets.** Synthetic resins, particularly polyester, epoxy, and polyvinyl chloride, are available as sheet materials. *These sheets are not referred to in the tables but may be used wherever comparable resin coatings are recommended.* They are often glass fiber reinforced and may be cemented to concrete with special adhesives.

19. **Lead sheet.** In the United States, lead sheet used for chemical resistance is called chemical lead. The sheets should be as large as possible (to minimize the number of joints) but not too heavy to handle—the thinnest sheet may be as large as 8×20 ft (2.5 × 6.0 m). Thicknesses range from 1/64 to ½ in. (0.4 to 12 mm). Lead may be cemented to concrete with an asphaltic paint. Each sheet should be overlapped and the seam welded by conventional lead-burning techniques. If the lead is to be subjected to high temperatures, it may be covered with chemical-resistant masonry to reduce thermal stresses.

20. **Glass.** Two types have been used for corrosion resistance: high-silica glass and borosilicate glass. Borosilicate glass, the more alkali-resistant material, is recommended because alkalies in concrete may cause glass etching. Glass may be cemented to the concrete. Thermal shock is often a cause of failure in glass-lined structures.

References

1. "A Guide to the Use of Waterproofing, Dampproofing, Protective, and Decorative Barrier Systems for Concrete," Report No. ACI 515.1R-79, *Concrete International*, November 1979.
2. Kleinlogel, A., *Influences on Concrete*, Frederick Ungar Publishing Co., New York, 1950.
3. Biczok, Imre, *Concrete Corrosion and Concrete Protection*, Akademai Kiado, Budapest, 1964.
4. ACI Committee 201, *Guide to Durable Concrete*, American Concrete Institute, Detroit, 1977.

Guide for the Selection of Protective Treatments

Adapted (with a few modifications) from Reference 1. Footnotes appear at the end of each table.

ACIDS

Material	Effect on concrete	Protective treatment
Acetic		
<10%	Slow disintegration	1, 2, 9, 10, 12, 14, 16 (b, c, e, f, g, h)
30%	Slow disintegration	9, 10, 14, 16 (c, e, f, g)
100% (glacial)	Slow disintegration	9, 16 (e, g)
Acid waters (pH of 6.5 or less)	Slow disintegration.* Natural acid waters may erode surface mortar but then action usually stops	1, 2, 3, 6, 8, 9, 10, 11, 12, 13, 16 (b, c, e, f, g, h), 17
Arsenious	None	
Boric	Negligible effect	2, 6, 7, 8, 9, 10, 12, 13, 15, 16 (b, c, e, f, g, h), 17, 19
Butyric	Slow disintegration	3, 4, 8, 9, 10, 12, 16 (b, c, e, f)
Carbolic	Slow disintegration	1, 2, 16 (c, e, g), 17
Carbonic (soda water)	0.9 to 3 ppm of carbon dioxide dissolved in natural waters disintegrates concrete slowly	2, 3, 4, 8, 9, 10, 12, 13, 15, 16 (b, c, e, f, h), 17
Chromic:		
5%	None*	2, 6, 7, 8, 9, 10, 16 (f, g, h), 19
50%	None*	16 (g), 19
Formic:		
10%	Slow disintegration	2, 5, 6, 7, 10, 12, 13, 16 (b, c, e, g), 17
90%	Slow disintegration	2, 7, 10, 13, 16 (c, e, g), 17
Humic	Slow disintegration possible, depending on humus material	1, 2, 3, 9, 10, 12, 15, 16 (b, c, e)
Hydrochloric:		
10%	Rapid disintegration, including steel	2, 5, 6, 7, 8, 9, 10, 12, 14, 16 (b, c, e, f, g, h), 17, 19, 20
37%	Rapid disintegration, including steel	5, 6, 8, 9, 10, 16 (c, e, f, g, h)
Hydrofluoric:		
10%	Rapid disintegration, including steel	5, 6, 7, 8, 9, 12, 16 (carbon and graphite brick; b, c, e, f, g), 17
75%	Rapid disintegration, including steel	16 (carbon and graphite brick; e, h), 17
Hypochlorous, 10%	Slow disintegration	5, 8, 9, 10, 16 (f, g)
Lactic, 5%	Slow disintegration	3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 15, 16 (b, c, e, f, g, h), 17
Nitric:		
2%	Rapid disintegration	6, 8, 9, 10, 13, 16 (f, g, h), 20
40%	Rapid disintegration	8, 16 (g)
Oleic, 100%	None	
Oxalic	No disintegration. It protects concrete against acetic acid, carbon dioxide, and salt water. POISONOUS, it must not be used on concrete in contact with food or drinking water.	
Perchloric, 10%	Disintegration	8, 10, 16 (e, f, g)
Phosphoric:		
10%	Slow disintegration	1, 2, 3, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16 (b, c, e, f, g, h), 17, 19

Phosphoric 85%	Slow disintegration	1, 2, 3, 5, 7, 8, 9, 10, 13, 14, 15, 16 (c, e, f, g, h), 17, 19
Stearic	Rapid disintegration	5, 6, 8, 9, 10, 11, 12, 13, 15, 16 (b, c, e, f, g, h), 17
Sulfuric: 10%	Rapid disintegration	5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16 (b, c, e, f, g, h), 17, 19, 20
110% (oleum)	Disintegration	16 (g), 19
Sulfurous	Rapid disintegration	6, 7, 9, 10, 11, 12, 13, 16 (b,c, e, h), 19, 20
Tannic	Slow disintegration	1, 2, 3, 6, 7, 8, 9, 10, 11, 12, 13, 16 (b, c, e, g), 17
Tartaric, solution	None. See wine under "Miscellaneous."	

*In porous or cracked concrete, it attacks steel. Steel corrosion may cause concrete to spall.

SALTS AND ALKALIES (SOLUTIONS)*

Material	Effect on concrete	Protective treatments
Bicarbonate: Ammonium, Sodium	None	
Bisulfate: Ammonium** , Sodium	Disintegration	5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 (b, c, e, f, h), 17
Bisulfite: Sodium	Disintegration	5, 6, 7, 8, 9, 10, 12, 13, 16 (b, c, e, f, h), 17
Calcium (sulfite solution)	Rapid disintegration	7, 8, 9, 10, 12, 13, 16 (b, c, e, f, h), 17
Bromide, sodium	Slow disintegration	1, 2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16 (b, c, e, f, h), 17
Carbonate: Ammonium, Potassium, Sodium	None	
Chlorate, sodium	Slow disintegration	1, 4, 6, 7, 8, 9, 10, 16 (f, g, h), 17, 19
Chloride: Calcium†, Potassium, Sodium†, Strontium	None, unless concrete is alternately wet and dry with the solution**	1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16 (b, c, e, f, g, h), 17
Ammonium, Copper, Ferric (iron), Ferrous, Magnesium, Mercuric, Mercurous, Zinc	Slow disintegration**	1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16 (b, c, e, f, g, h), 17
Aluminum	Rapid disintegration**	1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16 (b, c, e, f, h), 17
Chromate, sodium	None	
Cyanide: Ammonium, Potassium, Sodium	Slow disintegration	7, 8, 9, 10, 12, 13, 16 (b, c), 17
Dichromate: Sodium	Slow disintegration with dilute solutions	1, 2, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16 (b, c, e, f, h), 17
Potassium	Disintegration	1, 2, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16 (b, c, e, f, h), 17
Ferrocyanide, sodium	None	
Fluoride: Ammonium, Sodium	Slow disintegration	3, 4, 8, 9, 10, 13, 16 (a, c, e, h), 17
Fluosilicate, magnesium	None	
Hexametaphosphate, sodium	Slow disintegration	5, 6, 7, 8, 9, 10, 12, 13, 15, 16 (b, c, e), 17
Hydroxide: Ammonium, Barium, Calcium, Potassium, 15%††, Sodium, 10%††	None	
Potassium, 25%, Sodium, 20%	Disintegration. Use of calcareous aggregate lessens attack.	5, 7, 8, 10, 12, 13, 14, 15, 16 (carbon and graphite brick, b, c), 17
Nitrate: Calcium, Ferric, Zinc	None	
Lead, Magnesium, Potassium, Sodium	Slow disintegration	2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 16 (b, c, e, f, g, h), 17, 20
Ammonium	Disintegration**	2, 5, 6, 8, 9, 10, 11, 12, 13, 16 (b, c, e, f, g, h), 17, 20
Nitrite, sodium	Slow disintegration	1, 2, 5, 6, 7, 8, 9, 10, 12, 13, 16 (b, c), 17
Orthophosphate, sodium (dibasic and tribasic)	None	
Oxalate, ammonium	None	
Perborate, sodium	Slow disintegration	1, 4, 7, 8, 9, 10, 13, 16 (d, f, g, h), 17
Perchlorate, sodium	Slow disintegration	6, 7, 8, 10, 16 (f, g, h), 17
Permanganate, potassium	None	
Persulfate, potassium	Disintegration of concrete with inadequate sulfate resistance	1, 2, 5, 7, 8, 9, 10, 12, 13, 16 (b, c, e, f, h), 17
Phosphate, sodium (monobasic)	Slow disintegration	5, 6, 7, 8, 9, 10, 12, 15, 16 (b,c), 17
Pyrophosphate, sodium	None	
Stannate, sodium	None	
Sulfate: Ammonium	Disintegration**	5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 (b, c, e, f, g, h), 17
Aluminum, Calcium, Cobalt, Copper, Ferric, Ferrous (iron vitriol), Magnesium (epsom salt), Manganese, Nickel, Potassium	Disintegration of concrete with inadequate sulfate resistance. Concrete products cured in high-pressure steam are highly resistant to sulfates.	1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16 (b, c, e, f, g, h), 17
Potassium aluminum (alum), Sodium, Zinc	Disintegration of concrete with inadequate sulfate resistance. Concrete products cured in high-pressure steam are highly resistant to sulfates.	1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16 (b, c, e, f, g, h), 17
Sulfide: Copper, Ferric, Potassium	None unless sulfates are present	7, 8, 9, 10, 12, 13, 15, 16 (b, c, e, f, h), 17

Sulfide		
Sodium	Slow disintegration	6, 7, 8, 9, 10, 11, 12, 13, 15, 16 (b, c), 17
Ammonium	Disintegration	7, 8, 9, 10, 12, 13, 15, 16 (a, b, c, e), 17
Sulfite:		
Sodium	None unless sulfates are present	1, 2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16 (b, c, e), 17
Ammonium	Disintegration	8, 9, 10, 12, 15, 16, (b, c, e, h), 17
Superphosphate, ammonium	Disintegration**	8, 9, 10, 12, 13, 15, 16 (b, c, e), 17, 19
Tetraborate, sodium (borax)	Slow disintegration	5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16 (b, c, e, f, g, h), 17
Thiosulfate:		
Sodium	Slow disintegration of concrete with inadequate sulfate resistance	1, 2, 5, 6, 7, 8, 9, 10, 12, 13, 15, 16 (b, c, e), 17
Ammonium	Disintegration	8, 9, 12, 13, 15, 16 (b, c, e), 17

*Dry materials generally have no effect.

**In porous or cracked concrete, it attacks steel. Steel corrosion may cause concrete to spall.

†Frequently used as a de-icer for concrete pavements. If the concrete contains insufficient entrained air or has not been air-dried for at least 30 days after completion of curing, repeated application may cause surface scaling. See de-icers under "Miscellaneous."

††If concrete is made with reactive aggregates, disruptive expansions may occur.

PETROLEUM OILS

Material	Effect on concrete	Protective treatments
Heavy oil below 35° Baumé* Paraffin	None	
Gasoline Kerosene Light oil above 35° Baumé* Ligroin Lubricating oil* Machine oil* Mineral spirits	None. Impervious concrete is required to prevent loss from penetration, and surface treatments are generally used.	1, 2, 3, 8, 10, 11, 12, 14, 16 (b, c, e, f), 17, 19
Gasoline, high octane	None. Surface treatments are generally used to prevent contamination with alkalies in concrete.	10, 11, 14, 17

*May contain some vegetable or fatty oils and the concrete should be protected from such oils.

COAL TAR DISTILLATES

Material	Effect on concrete	Protective treatments
Alizarin Anthracene Carbazole Chrysen Pitch	None	
Benzol (benzene) Cumol (cumene) Phenanthrene Toluol (toluene) Xylol (xylene)	None. Impervious concrete is required to prevent loss from penetration, and surface treatments are generally used.	1, 2, 11, 12, 16 (b, c, e, f, g), 19
Creosote Cresol Dinitrophenol Phenol, 5%-25%	Slow disintegration	1, 2, 16 (c, e, g), 17, 19

SOLVENTS AND ALCOHOLS

Material	Effect on concrete	Protective treatments
Carbon tetrachloride	None*	1, 2, 10, 12, 16 (b, c, e, g)
Ethyl alcohol	None* (see de-icers under "Miscellaneous")	1, 2, 5, 7, 10, 12, 13, 14, 16 (b, c, e, f, g, h), 17, 19
Ethyl ether	None*	11, 12, 16 (c, e), 19
Methyl alcohol	None*	1, 2, 5, 7, 10, 12, 13, 14, 16 (b, c, e, f, g, h), 17, 19
Methyl ethyl ketone	None*	16 (c, e), 17, 19
Methyl isoamyl ketone	None*	16 (c, e), 17
Methyl isobutyl	None*	16 (c, e), 17
Perchloroethylene	None*	12, 16 (b, c, e)
t-Butyl alcohol	None*	1, 2, 5, 7, 10, 12, 13, 14, 16 (b, c, e, f, g, h), 17, 19
Trichloroethylene	None*	1, 2, 12, 16 (b, c, e, g)
Acetone	None.* However, acetone may contain acetic acid as impurity (see under "Acids").	1, 2, 16 (c, e, g), 17, 19
Carbon disulfide	Slow disintegration possible	1, 2, 11, 16 (c, e, g)
Glycerin (glycerol)	Slow disintegration possible	1, 2, 3, 4, 7, 10, 11, 12, 13, 16 (b, c, e, f, g), 17
Ethylene glycol**	Slow disintegration	1, 2, 7, 10, 12, 13, 14, 16 (b, c, e, f, g, h), 17

*Impervious concrete is required to prevent loss from penetration, and surface treatments are generally used.

**Frequently used as de-icer for airplanes. Heavy spillage on concrete containing insufficient entrained air may cause surface scaling.

VEGETABLE OILS

Material	Effect on concrete	Protective treatments
Rosin and rosin oil	None	
Turpentine	Mild attack and considerable penetration	1, 2, 10, 11, 12, 14, 16 (b, c, e)
Almond China wood* Linseed* Olive Peanut Poppy seed Soybean* Tung* Walnut	Slow disintegration	1, 2, 8, 10, 11, 12, 14, 16 (b, c, e, f), 17. For expensive cooking oils, use 20.
Margarine	Slow disintegration—faster with melted margarine	1, 2, 8, 10, 11, 12, 13, 16 (b, c, e, f)
Castor Cocoa bean Cocoa butter Coconut Cottonseed Mustard Rapeseed	Disintegration, especially if exposed to air	1, 2, 8, 10, 11, 12, 14, 16 (b, c, e, f), 17

*Applied in thin coats, the material quickly oxidizes and has no effect. The effect indicated above is for constant exposure to the material in liquid form.

FATS AND FATTY ACIDS (ANIMAL)

Material	Effect on concrete	Protective treatments
Fish liquor	Disintegration	3, 8, 10, 12, 13, 16 (b, c, e, f), 17
Fish oil	Slow disintegration with most fish oils	1, 2, 3, 8, 10, 12, 13, 16 (b, c, e, f), 17
Whale oil	Slow disintegration	1, 2, 3, 8, 10, 12, 13, 16 (b, c, e, f), 17
Neatsfoot oil Tallow and tallow oil	Slow disintegration	1, 2, 3, 8, 10, 12, 13, 16 (b, c, e, f), 17
Beef fat Horse fat Lamb fat	Slow disintegration with solid fat—faster with melted	1, 2, 3, 8, 10, 12, 13, 16 (b, c, e, f), 17
Lard and lard oil	Slow disintegration—faster with oil	1, 2, 3, 8, 10, 12, 13, 16 (b, c, e, f), 17
Slaughterhouse wastes	Disintegration due to organic acids	8, 10, 12, 13, 16 (b, c, e)

MISCELLANEOUS

Material	Effect on concrete	Protective treatments
Alum	See sulfate, potassium aluminum, under "Salts and Alkalies"	
Ammonia:		
Liquid	None, unless it contains harmful ammonium salts (see under "Salts and Alkalies")	
Vapors	Possible slow disintegration of moist concrete and steel attacked in porous or cracked moist concrete	8, 9, 10, 12, 13, 16 (a, b, c, f), 17
Ashes:		
Cold	Harmful if wet, when sulfides and sulfates leach out (see sulfate, sodium, under "Salts and Alkalies")	1, 2, 3, 8, 9, 10, 12, 13, 16 (b, c, e)
Hot	Thermal expansion	16 (calcium aluminate cement, fireclay, and refractory-silicate-clay mortars)
Automobile and diesel exhaust gases	Possible disintegration of moist concrete by action of carbonic, nitric, or sulfurous acid (see under "Acids")	1, 5, 8, 10, 12, 16 (b, c, e)
Baking soda	None	
Beer	No progressive disintegration, but in beer storage and fermenting tanks a special coating is used to guard against beer contamination. Beer may contain, as fermentation products, acetic, carbonic, lactic, or tannic acids (see under "Acids").	8, 10, 11, 12, 16 (b, c, f), 17, coatings made and applied by Borsari Tank Corp. of America, 122 E. 42nd St., New York, N.Y. 10017
Bleaching solution	See the specific chemical, such as hypochlorous acid, sodium hypochlorite, sulfurous acid, etc.	
Borax (salt)	See tetraborate, sodium, under "Salts and Alkalies"	
Brine	See chloride, sodium, or other salts under "Salts and Alkalies"	
Bromine	Disintegration if bromine gaseous—or if a liquid containing hydrobromic acid and moisture	10, 13, 16 (f, g)
Buttermilk	Slow disintegration due to lactic acid	2, 3, 4, 7, 8, 9, 10, 11, 12, 13, 16 (b, c, e, f), 17
Carbon dioxide	Gas may cause permanent shrinkage. See carbonic acid under "Acids."	1, 2, 3, 6, 8, 9, 10, 11, 12, 13, 15, 16 (b, c, e, f, h), 17
Caustic soda	See hydroxide, sodium, under "Salts and Alkalies"	
Chile saltpeter	See nitrate, sodium, under "Salts and Alkalies"	
Chlorine gas	Slow disintegration of moist concrete	2, 8, 9, 10, 16 (f, g), 17
Chrome plating solutions	Slow disintegration	7, 8, 9, 10, 16 (f, g), 20
Cider	Slow disintegration. See acetic acid under "Acids."	1, 2, 9, 10, 12, 14, 16 (b, c, e, f, g), 17
Cinders cold and hot	See ashes above	
Coal	None, unless coal is high in pyrites (sulfide of iron) and moisture. Sulfides leaching from damp coal may oxidize to sulfurous or sulfuric acid, or ferrous sulfate (see under "Acids" and "Salts and Alkalies"). Rate is greatly retarded by deposit of an insoluble film.	1, 2, 3, 6, 7, 8, 9, 10, 12, 13, 16 (b, c, e, h), 17
Coke	Sulfides leaching from damp coke may oxidize to sulfurous or sulfuric acid (see under "Acids").	1, 2, 3, 6, 7, 8, 9, 10, 12, 13, 16 (b, c, e, h)
Copper plating solutions	None	
Corn syrup (glucose)	Slow disintegration	1, 2, 3, 7, 8, 9, 10, 12, 13, 16 (b, c, e), 17
De-icers	Chlorides (calcium and sodium), urea, and ethyl alcohol cause scaling of non-air-entrained concrete.	50% solution of boiled linseed oil in kerosene, soybean oil, modified castor oil, cottonseed oil, sand-filled epoxy, or coal-tar epoxy
Distiller's slop	Slow disintegration due to lactic acid	1, 8, 9, 10, 12, 13, 15, 16 (b, c, e, f, h), 17
Fermenting fruits, grains, vegetables, or extracts	Slow disintegration. Industrial fermentation processes produce lactic acid (see under "Acids").	1, 2, 3, 8, 9, 10, 12, 16 (b, c, e), 17
Flue gases	Hot gases (400-1100° F.) cause thermal stresses. Cooled, condensed sulfurous, hydrochloric acids disintegrate concrete slowly.	9 (high melting), 16 (g, fireclay mortar)
Formaldehyde, 37% (formalin)	Slow disintegration due to formic acid formed in solution	2, 5, 6, 8, 10, 11, 12, 13, 14, 16 (b, c, e, f, g, h), 17, 20
Fruit juices	Little if any effect for most fruit juices as tartaric and citric acids do not appreciably affect concrete. Sugar and hydrofluoric and other acids cause disintegration.	1, 2, 3, 6, 7, 8, 9, 10, 11, 12, 16 (b, c, e), 17
Gas water	Ammonium salts seldom present in sufficient quantity to disintegrate concrete	9, 10, 12, 16 (b, c)
Glyceryl tristearate	None	
Honey	None	
Hydrogen sulfide	Slow disintegration in moist oxidizing environments where hydrogen sulfide converts to sulfurous acid	1, 2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 16 (b, c, e, f, g, h), 17, 19
Iodine	Slow disintegration	1, 2, 6, 10, 12, 13, 16 (b, c, e, g), 17
Lead refining solution	Slow disintegration	1, 2, 6, 8, 9, 10, 12, 16 (carbon and graphite brick; b, c, e, h), 17, 20

Lignite oils	Slow disintegration if fatty oils present	(b, c, e, f)
Lye	See hydroxide, sodium and potassium, under "Salts and Alkalies"	
anure	Slow disintegration	1, 2, 8, 9, 10, 12, 13, 16 (b, c, e)
Mash, fermenting	Slow disintegration due to acetic and lactic acids and sugar	1, 8, 9, 10, 12, 13, 16 (b, c)
Milk	None, unless milk is sour. Then lactic acid disintegrates concrete slowly.	3, 4, 8, 9, 10, 11, 12, 13, 16 (b, c, f), 17
Mine water, waste	Sulfides, sulfates, or acids present disintegrate concrete and attack steel in porous or cracked concrete	1, 2, 5, 8, 9, 10, 12, 13, 15, 16 (b, c, e, f, h), 17
Molasses	Slow disintegration at temperatures ≥120° F	1, 2, 7, 8, 9, 10, 12, 13, 16 (b, c, e), 17
Nickel plating solutions	Slow disintegration due to nickel ammonium sulfate	2, 5, 6, 7, 8, 9, 10, 13, 16 (c, e, f), 17
Niter	See nitrate, potassium, under "Salts and Alkalies"	
Ores	Sulfides leaching from damp ores may oxidize to sulfuric acid or ferrous sulfate (see under "Acids" and "Salts and Alkalies")	2, 9, 10, 12, 13, 15, 16 (b, c, e, f, g), 17
Pickling brine	Steel attacked in porous or cracked concrete. See salts, boric acid, or sugar.	1, 7, 8, 9, 10, 12, 13, 16 (b, c, e, h), 17
Sal ammoniac	See chloride, ammonium, under "Salts and Alkalies"	
Sal soda	See carbonate, sodium, under "Salts and Alkalies"	
Saltpeter	See nitrate, potassium, under "Salts and Alkalies"	
Sauerkraut	Slow disintegration possible due to lactic acid. Flavor impaired by concrete.	1, 2, 8, 9, 10, 12, 13, 16 (b, c, e, f), 17
Sea water	Disintegration of concrete with inadequate sulfate resistance and steel attacked in porous or cracked concrete	1, 2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 (b, c, e, f), 17
Sewage and sludge	Usually not harmful. See hydrogen sulfide above.	
Silage	Slow disintegration due to acetic, butyric, and lactic acids, and sometimes fermenting agents of hydrochloric or sulfuric acids	3, 4, 8, 9, 10, 12, 16 (b, c, e, f)
Sodium hypochlorite	Slow disintegration	7, 8, 9, 10, 13, 16 (d, f), 17
Sugar (sucrose)	None with dry sugar on thoroughly cured concrete. Sugar solutions may disintegrate concrete slowly.	1, 2, 3, 7, 8, 9, 10, 12, 13, 15, 16 (b, c, e, f), 17
Sulfite liquor	Disintegration	1, 2, 3, 5, 6, 8, 9, 10, 12, 13, 16 (b, c, e, f, h), 17, 19
Sulfur dioxide	None if dry. With moisture, sulfur dioxide forms sulfurous acid.	2, 5, 6, 8, 9, 10, 12, 13, 16 (b, c, e, f, g, h), 17, 19
Tanning bark	Slow disintegration possible if damp. See tanning liquor below.	1, 2, 3, 6, 8, 9, 10, 11, 12, 13, 16 (b, c, e), 17
Tanning liquor	None with most liquors, including chromium. If liquor is acid, it disintegrates concrete.	1, 2, 3, 5, 6, 8, 9, 10, 11, 12, 13, 16 (b, c, e), 17
Tobacco	Slow disintegration if organic acids present	1, 8, 9, 10, 12, 13, 16 (b, c, e, f), 17
Trisodium phosphate	None	
Urea	None (see de-icers)	
Urine	None, but steel attacked in porous or cracked concrete	7, 8, 10, 12, 13, 16 (b, c, e)
Vinegar	Slow disintegration due to acetic acid	9, 10, 12, 16 (b, c, e, h), 17
Washing soda	None	

(<75 ppm o. carbonate hardness)	[illegible] us of cracked concrete	[illegible] 12, 16 (b, c, e, f, h), 17
Whey	Slow disintegration due to lactic acid	3, 4, 5, 7, 8, 9, 10, 12, 13, 16 (b, c, e, f, h), 17
Wine	None—but taste of first wine batch may be affected unless concrete has been given tartaric acid treatment	For fine wines 2 or 3 applications of tartaric acid solution (1 lb tartaric acid in 3 pints water) 2, 8, 10, 12, 16 (b) 2[illegible]
Wood pulp	None	
Zinc refining solutions	Disintegration if hydrochloric or sulfuric acids present	8, 9, 10, 12, 13, 16 (b, c, e, f, h), 17
Zinc slag	Zinc sulfate (see under "Salts and Alkalies") may be formed by oxidation	8, 9, 10, 12, 13, 16 (b, c, e, f, h), 17

Sources of Products To Protect Concrete Against Aggressive Substances*

1706-KE

4/24/87, Rev. n

1. Magnesium and Zinc Fluosilicates or Magnesium Silicofluoride

American Cyanamid Company
Industrial Chemical Division
Berdan Avenue
Wayne, N.J. 07470

American Fluoride Corporation
17 Huntington Place
New Rochelle, N.Y. 10801

Davison Chemical Division
W. R. Grace & Company
P. O. Box 2117
Baltimore, Md. 21203

Devoe/Truscon
Division of Celanese Coatings Company
Box 1863
Louisville, Ky. 40201

W. R. Grace and Company of Canada Ltd.
294 Clements Road West
Ajax, Ont. L1S 3C6

Harshaw Chemical Company
1933 East 97th Street
Cleveland, Ohio 44106

Hummel Chemical Company, Inc.
Harmich Road
South Plainfield, N.J. 07080

Sika Canada Inc.
601 Delmar Avenue
Pointe Claire, Que. H9R 4A9

Sika Corporation
Box 297
Lyndhurst, N.J. 07071

Sonneborn Building Products
Division of Contech, Inc.
7711 Computer Avenue
Minneapolis, Minn. 55435

Toch Bros., Inc.
350 Hanley Ind. Ct.
St. Louis, Mo. 63144

2. Sodium Silicate

American Cyanamid Company
Industrial Chemical Division
Berdan Avenue
Wayne, N.J. 07470

Ashland Chemical Company
Industrial Chemicals & Solvents Division
Box 2219
Columbus, Ohio 43216

Chemical Products Corp.
48 Atlanta Road
Cartersville, Ga. 30210

Diamond Crystal Salt Company
916 South Riverside
St. Clair, Mich. 48079

E. I. DuPont de Nemours & Company, Inc
Chemicals, Dyes & Pigments Department
Wilmington, Del. 19898

National Silicates Limited
429 Kipling Avenue
P. O. Box 69
Toronto, Ont. M8V 3S7

The PQ Corporation
P. O. Box 840
Valley Forge, Pa. 19482

Philipp Brothers Chemicals, Inc.
1221 Avenue of Americas
New York, N.Y. 10020

Sonneborn Building Products
Division of Contech, Inc.
7711 Computer Avenue
Minneapolis, Minn. 55435

3. Drying Oils (Linseed)

Commercially available locally.

4. Coumarone-Indene and Hydrocarbon Resins

Allied Chemical Canada Ltd.
237 Hymus Boulevard
Pointe Claire, Que. H9R 1G3

Hercules, Inc.
910 Market Street
Wilmington, Del. 19899

Neville Chemical Company
1938 Neville Island
Pittsburgh, Pa. 15225

5. Styrene-Butadiene

Borg-Warner Chemicals
Division of Borg-Warner Company
International Center
Parkersburg, W. Va. 26101

Dow Chemical
P. O. Box 1012
Sarnia, Ont. N7T 7K7

Dow Chemical U.S.A.
1400 East Touhy Avenue
Des Plaines, Ill. 60018

Federal International Chemicals
1191 South Wheeling Road
Wheeling, Ill. 60090

Goodyear Tire & Rubber Company
Chemical Division
1144 East Market Street
Akron, Ohio 44316

Imperial Oil Ltd
111 St. Clair Avenue W
Toronto, Ont. M5W 1K3

Koppers Company, Inc.
Organic Materials Group
Koppers Building
Pittsburgh, Pa. 15219

Ploysar Limited
201 North Front Street
Sarnia, Ont. N7T 7V1

6. Chlorinated Rubber

Chemical Manufacturing Company, Inc.
Subsidiary of Imperial Chemical Industries Ltd.
2412 Eads
Los Angeles, Calif. 90031

Federal International Chemicals
1191 South Wheeling Road
Wheeling, Ill. 60090

Hercules, Inc.
910 Market Street
Wilmington, Del. 19899

Koppers Company, Inc.
Organic Materials Group
Koppers Building
Pittsburgh, Pa. 15219

7. Chlorosulfonated Polyethylene (Hypalon)

E. I. DuPont de Nemours & Company, Inc.
Polymer Products Department
Elastomers Division
1007 Market Street
Wilmington, Del. 19898

8. Vinyls

American Paint Corporation
P. O. Box 6065
Duluth, Minn.

Ameron Protective Coatings Division
201 North Berry Street
Brea, Calif. 92621

Atlas Minerals and Chemicals, Inc.
Farmington Road
Mertztown, Pa. 19539

Bate Chemical Company
160 Lesmill Road
Don Mills, Ont. M3B 2T7

*This list is furnished to assist in locating various products and does not imply Portland Cement Association endorsement or approval.

The list represents firms that make only the basic materials as well as firms that make finished products. Firms that make only basic materials are willing to supply names of their customers that make the finished products.

Borden Chemicals
Division of Borden Company
595 Coronation Drive
West Hill, Ont. M1E 4R9

Borden Chemicals
Western Div. of Borden Company
1550 Rand Avenue
P. O. Box 58098
Vancouver, B.C. V6P 6C5

Borden Chemical Company
511 Lancaster Street
Leominster, Mass. 01453

Canadian Industries Ltd.
P. O. Box 10
Montreal, Que. H3C 2R3

Carboline Company
350 Hanley Industrial Court
St. Louis, Mo. 63144

Ceilcote Company
140 Sheldon Road
Berea, Ohio 44017

Celanese Plastics and
Specialties Company
Resins Division
P. O. Box 8248
Louisville, Ky. 40208

E. I. DuPont de Nemours &
Company, Inc.
Polymer Products Department
Elastomers Division
1007 Market Street
Wilmington, Del. 19898

Essex Chemical Corporation
Specialty Chemicals Division
One Crossman Road
Sayreville, N.J. 08872

Ethyl Corporation
330 South 4th
Richmond, Va. 23219

H. B. Fuller Canada Inc.
88 Industrial Boulevard
Boucherville, Que. J4B 2X2

Gates Engineering Company, Inc.
100 South West Street
Wilmington, Del. 19899

B. F. Goodrich Canada Ltd.
409 Weber West
Kitchener, Ont. N2H 4B1

B. F. Goodrich Chemical Group
6100 Oak Tree Boulevard
Cleveland, Ohio 44131

Kopper Company, Inc.
Organic Materials Group
Koppers Building
Pittsburgh, Pa. 15219

PPG Industries
Coatings and Resins Division
50 St. Clair Avenue W
Toronto, Ont. M4V 1M9

PPG Industries, Inc.
Coatings & Resins Division
Manufacturers of Pittsburgh Paints
One Gateway Center
Pittsburgh, Pa. 15222

Plas-Chem Corporation
6302 Bartmer Industrial Drive
St. Louis, Mo. 63130

Polysar Limited
201 North Front Street
Sarnia, Ont. N7T 7V1

Reichhold Chemicals, Inc.
525 North Broadway
White Plains, N.Y. 10603

Reichhold Limited
600 The East Mall
Islington, Ont. M9B 4B1

Stauffer Chemical Company
Plastics Division
Nyala Farm Road
Westport, Conn. 06880

St. Lawrence Resin Products Ltd.
350 Wentworth Street N
Hamilton, Ont. L8L 5W3

Union Carbide Corporation
Plastics Division
270 Park Avenue
New York, N.Y. 10017

U. S. Stoneware Company
5300 East Tallmadge Avenue
Akron, Ohio 44309

9. Bituminous Paints, Mastics, and Enamels

Ameron Protective Coatings
Division
201 North Berry Street
Brea, Calif. 92621

Almatex Limited
P. O. Box 2274, Terminal 'A'
London, Ont. N6A 4E8

Apco Industries Co. Ltd.
10 Industrial Street
Toronto, Ont. M4G 1Z1

Atlas Minerals and
Chemicals, Inc.
Farmington Road
Mertztown, Pa. 19539

Bapco Paint Ltd.
13151 - 80th Avenue
P. O. Box 9011
Surrey, B.C. V3T 4Y4

Barber Asphalt Paving Company
Barber, N.J.

W. A. Briggs Bitumen Company
c/o IPA Systems, Inc.
2743 N. Amber Street
Philadelphia, Pa. 19134

Buckeye Paint & Varnish Company
3117 Darlington Road
Toledo, Ohio 43606

Building Products of Canada Ltd.
10500 Coter de Liesse, Suite 200
Lachine, Que. H8T 3E3

Canadian Industries Ltd.
Paints Division
P. O. Box 10
Montreal, Que. H3C 2R3

Ceilcote Company
140 Sheldon Road
Berea, Ohio 44017

P. O. Box 860
Valley Forge, Pa. 19482

Chevron Asphalt Ltd
43 Industrial Street
Toronto, Ont. M4G 1Z2

DeSoto Coatings Ltd.
120 - 24th Street
Toronto, Ont. M8V 3P1

Devoe-Truscon
Div. of Celanese Coatings Company
Box 1863
Louisville, Ky. 40201

Domtar Chemicals Group
395 de Maisonneuve Boulevard, W
P. O. Box 7212
Montreal, Que. H3C 3M3

E. I. DuPont de Nemours & Co. Inc.
Fabrics & Finishes Department
Wilmington, Del 19898

Elsro Asphalt Ltd.
12944 - 148th Street
Edmonton, Alta. T5L 2H8

Flintkote Company of Canada Ltd.
P. O. Box 160, Station 'N'
Toronto, Ont. M8V 3T4

Glidden Coatings & Resins
Division of SCM Corporation
900 Union Commerce Building
Cleveland, Ohio 44115

Glidden Company
Division of SCM (Canada) Ltd.
351 Wallace Avenue
Toronto, Ont. M6P 3N9

Gulf Canada Ltd.
800 Bay Street
Toronto, Ont. M5S 1Y8

Hercules, Inc.
910 Market Street
Wilmington, Del. 19899

Insul-Mastic & Building Products
586 W. 6th Avenue
Vancouver, B.C. V5Z 1A1

International Paints (Canada)
6615 Park Avenue
Montreal, Que. H2V 4P6

Johns-Manville
Building Systems Division
Ken-Caryl Ranch
Denver, Colo. 80217

Koppers Company, Inc.
Organic Materials Group
Koppers Building
Pittsburgh, Pa. 15219

Mulco Inc.
2835 Grande Allée
St. Hubert, Que. J4T 3K3

Maintenance, Inc.
P. O. Drawer 408
Wooster, Ohio 44691

PPG Industries, Inc.
Coatings & Resins Division
Manufacturers of Pittsburgh Paints
One Gateway Center
Pittsburgh, Pa. 15222

Plas-Chem Corporation
6302 Bartmer Industrial Drive
St. Louis, Mo 63130

Reilly Tar & Chemical Corporation
151 North Delaware Street
Indianapolis, Ind. 46204

Reliance Paint Company
401 Wythe Avenue
Brooklyn, N.Y. 11211

RPM Canada
12 Finley Road
Bramalea, Ont. L6T 1A9

Rulon Company
Div. of Colonial Industries, Inc.
Linwood & Pine Avenues
Maple Shade, N.J. 08052

Set Products (Canada) Ltd.
55 Livingston Road, Penthouse 4
Scarborough, Ont. M1E 1K7

Sika Corporation
Box 297
Lyndhurst, N.J. 07071

Société Chimique Laurentide Inc.
4650 -12th Avenue
Shawinigan South, P. O. Box 367
Que. G9N 6V1

Sonneborn Building Products
Division of Contech, Inc.
7711 Computer Avenue
Minneapolis, Minn. 55435

Spicers Asbestos
95 East - 1st Avenue
Vancouver, B.C. V5T 1A2

Sterling Varnish
5 - 9 Philip Street
P. O. Box 554
St. Catharines, Ont. L2R 6X1

Sternson Ltd.
22 Mohawk Street
P. O. Box 130
Brantford, Ont. N3T 5N1

Stonhard Company
One Park Avenue
Maple Shade, N.J. 08052

Technical Coatings Company Ltd.
1164 Walkers Line
Burlington, Ontario L7M 1V2

Toch Bros., Inc.
350 Hanley Ind. Ct.
St. Louis, Mo. 63144

Victo Mix Alsfib Inc.
87 Avenue Pie X
Victoriaville, Que. G6P 6W2

Witco Chemical Company
277 Park Avenue
New York, N.Y. 10017

Zophar Mills, Inc.
112 - 26th Street
Brooklyn, N.Y. 11232

10. Polyester

Allied Chemical Corporation
Fibers and Plastic Company
1411 Broadway
New York, N.Y. 10018

Allied Ch[illegible]
237 Hymus [illegible]
Pointe Claire, Que H9R 1G3

American Cyanamid Company
Plastics & Resins Division
Berdon Avenue
Wayne, N.J 07470

Archer Daniels Midland Company
4666 Faries Parkway
Decatur, Ill. 62526

Ashland Chemicals Company
2620 Royal Windsor Drive
Mississauga, Ont. L5J 4E7

Ashland Chemical Company
Polyester Division
Box 2219
Columbus, Ohio 43216

Atlas Chemical Industries, Inc.
5-35 47th Avenue
Long Island City, N.Y. 11101

Augusta Fiberglass Coatings, Inc.
P. O. Drawer 1265
Barnwell, S.C. 29812

Bate Chemical Company
160 Lesmill Road
Don Mills, Ont. M3B 2T7

Canadian Industries Ltd.
P. O. Box 10
Montreal, Que. H3C 2R3

Ceilcote Company
140 Sheldon Road
Berea, Ohio 44017

Celanese Plastics and
Specialties Company
Resins Division
P. O. Box 8248
Louisville, Ky. 40208

Cook Paint & Varnish Company
P. O. Box 389
Kansas City, Mo. 64141

Corrosioneering, Inc.
Box 12
Grafton, Ohio 44044

DeSoto Chemical Coatings, Inc.
1700 South Mt. Prospect Road
Des Plaines, Ill. 60018

DeSoto Coatings Ltd.
120-24th Street
Toronto, Ont. M8V 3P1

Dudick Corrosion-Proof
Manufacturing Inc.
Box 139
Macedonia, Ohio 44056

Durez Plastics and Resins Division
Dunlop Street
Fort Erie, Ont. L2Z 5M6

Fiberglass Canada Ltd.
3080 Yonge Street
Toronto, Ont. M4N 3N1

Fiberplast Products Ltd.
6888 Burlington Avenue
Burnaby, B.C. V5J 4H1

Freeman Chemical Corporation
222 East Main Street
Port Washington, Wis. 53074

900 Union Commerce Building
Cleveland, Ohio 44115

Glidden Company Ltd.
351 Wallace Avenue
Toronto, Ont. M6P 3N9

Guardsman Chemical Coatings, Inc.
1350 Steele Avenue, S.W
Grand Rapids, Mich 49507

Interchemical Corporation
Finishes Division
1255 Broad Street
Clifton, N.J. 07015

Koppers Company, Inc.
Organic Materials Group
Koppers Building
Pittsburgh, Pa. 15219

Polysar Ltd.
201 North Front Street
Sarnia, Ont. N7T 7V1

PPG Industries, Inc.
Coatings & Resins Division
Manufacturers of Pittsburgh Paints
One Gateway Center
Pittsburgh, Pa. 15222

Reichhold Chemicals Inc.
525 N. Broadway
White Plains, N.Y. 10603

Reichhold Limited
600 The East Mall
Islington, Ont. M9B 4B1

Rigiline Corporation
Box 338
Brunswick, Ohio 76710

Rohm & Haas Company
10 Pelham Parkway
Pelham Manor, N.Y. 10803

Sherwin-Williams Company
P. O. Box 6027
Cleveland, Ohio 44101

Union Carbide Canada Ltd.
123 Eglinton Avenue, E.
Toronto, Ontario M4P 1J3

Union Carbide Corporation
Plastics Division
270 Park Avenue
New York, N.Y. 10017

Uniroyal Chemical
Erb Street
P. O. Box 250
Elmira, Ont. N3B 3A3

11. Urethane

Allied Chemical Corporation
Specialty Chemicals Division
Box 1087
Morristown, N.J. 07960

Allied Chemical Canada Ltd.
237 Hymus Boulevard
Pointe Claire, Que. H9R 1G3

Archer Daniels Midland Company
4666 Faries Parkway
Decatur, Ill. 62526

Carboline Company
350 Hanley Industrial Court
St Louis, Mo 63144

Ceilcote Company
140 Sheldon Road
Berea, Ohio 44017

Cook Paint & Varnish Company
P. O. Box 389
Kansas City, Mo. 64141

DeSoto Chemical Coatings
120 - 24th Street
Toronto, Ont. M8V 3P1

DeSoto Chemical Coatings, Inc.
1700 South Mt. Prospect Road
Des Plaines, Ill. 60018

E. I. DuPont de Nemours & Company, Inc.
Fabrics & Finishes Department
Wilmington, Del. 19898

Dutch Boy Coatings Group
Division of Dutch Boy, Inc.
2325 Hollins Ferry Road
Baltimore, Md. 21230

Essex Chemical Corporation
Specialty Chemicals Division
One Crossman Road
Sayreville, N.J. 08872

Federal International Chemicals
1191 South Wheeling Road
Wheeling, Ill. 60090

Gates Engineering Company, Inc.
100 South West Street
Wilmington, Del. 19899

B. F. Goodrich Chemical Group
6100 Oak Tree Boulevard
Cleveland, Ohio 44131

B. F. Goodrich Company, Ltd.
409 Weber West
Kitchener, Ont. N2H 4B1

Hughson Chemicals
Division of Lord Corporation
P. O. Box 1099
Erie, Pa. 16512

Koppers Company, Inc.
Organic Materials Group
Koppers Building
Pittsburgh, Pa. 15219

PPG Industries, Inc.
Coatings & Resins Division
Manufacturers of Pittsburgh Paints
One Gateway Center
Pittsburgh, Pa. 15222

Plas-Chem Corporation
6302 Bartmer Industrial Drive
St. Louis, Mo. 63130

Reichhold Chemicals Inc.
525 North Broadway
White Plains, N.Y. 10603

Reichhold Limited
600 The East Mall
Islington, Ont. M9B 4B1

Spencer Kellogg
Division of Textron, Inc.
100 Delaware Avenue
Buffalo, N.Y. 14240

Sonneborn Building Products
Division of Contech, Inc
7711 Computer Avenue
Minneapolis, Minn 55435

Tennant Company
701 North Lilac Drive
Minneapolis, Minn 55440

12. Epoxy

Celanese Plastics & Specialties Company
1065 West Hill Street
Louisville, Ky. 40208

Ciba-Geigy Corporation
Resins Department
Ardsley, N.Y. 10502

Dow Chemical Company
Plastics Division
2020 Dow Center
Midland, Mich. 48640

Dow Chemicals Ltd.
P. O. Box 1012
Sarnia, Ontario N7T 7K7

Dutch Boy Coatings Group
Division of Dutch Boy, Inc.
2325 Hollins Ferry Road
Baltimore, Md. 21230

Federal International Chemicals
1191 South Wheeling Road
Wheeling, Ill. 60090

Henkel Corporation
4620 West 77th Street
Minneapolis, Minn. 55435

Koppers Company, Inc.
Organic Materials Group
Koppers Building
Pittsburgh, Pa. 15219

PPG Industries, Inc.
coatings & Resins Division
Manufacturers of Pittsburgh Paints
One Gateway Center
Pittsburgh, Pa. 15222

Polysar Ltd.
201 North Front Street
Sarnia, Ont. N7T 7V1

Reichhold Chemicals Inc.
525 North Broadway
White Plains, N.Y. 10603

Reichhold Limited
600 The East Mall
Islington, Ont. M9B 4B1

Shell Chemical Company
Division of Shell Oil Company
One Shell Plaza
Houston, Tex. 77001

Union Carbide Corporation
Plastics Division
270 Park Avenue
New York, N.Y. 10017

R. T. Vanderbilt Company, Inc.
30 Winfield Street
Norwalk, Conn. 06855

13. Neoprene

E. I. DuPont de Nemours & Company, Inc
Polymer Products Department
Elastomers Division
1007 Market Street
Wilmington, Del. 19898

14. Polysulfide

Thiokol Chemical Corporation
P. O. Box 8296
Trenton, N.J. 08650

15. Coal Tar-Epoxy

Koppers Company, Inc
Organic Materials Group
Koppers Building
Pittsburgh, Pa. 15219

U. S. S. Chemicals Company
Division of U. S. Steel
600 Grant Street
Pittsburgh, Pa. 15230

16. Chemical-Resistant Masonry Units and Mortars, Toppings, or Overlays

Masonry Units Category

American Olean Tile Co
100 Cannon Avenue
Lansdale, Pa. 19446

Ameron Protective Coatings Div.
201 North Berry Street
Brea, Calif. 92621

Atlas Minerals and Chemicals, Inc.
Farmington Road
Mertztown, Pa. 19539

Belden Brick Company
700 Tuscarawas West
Canton, Ohio 44701

Birmingham Clay Products Company
2 Office Park Circle
Birmingham, Ala. 35223

C. C. Chemicals Ltd
Thornhill, Ont.

Carborundum Company
Refractories and Electronics Div.
P. O. Box 367
Niagara Falls, N.Y. 14302

Ceilcote Canada Ltd
Mississauga, Ont.

Ceilcote Company
140 Sheldon Road
Berea, Ohio 44017

Collier Company
2200 Brownsville Road
Pittsburgh, Pa. 15210

Corrosion Engineering Div.
Pennwalt Corp.
3 Parkway
Philadelphia, Pa. 19102

General Refractories Company
50 Monument Road
Bala Cynwyd, Pa. 19004

A. P. Green Fire Brick Company
1108 East Breckenridge Street
Mexico, Mo 65265

Hanley Company
691 Summerville Street
Summerville, Pa. 15864

Harbison-Walker Refractories Co.
2 Gateway Center
Pittsburgh, Pa. 15222

Madison Chemical Industries Ltd.
Milton, Ont.

Maurice A. Knight Company
P. O. Box 109
Akron, Ohio 44309

Mulco Inc.
St. Hubert, Que. J4T 3K3

National Carbon Company
Division of Union Carbide Corp.
270 Park Avenue
New York, N.Y. 10017

Plibrico Company
1800 Kingsbury Street
Chicago, Ill. 60614

Richland Shale Brick Company
P. O. Box 1433
Mansfield, Ohio 44901

Rulon Company
Division of Colonial
Industries, Inc.
Linwood & Pine Avenues
Maple Shade, N.J. 08052

Saureisen Cements Company
RIDC Industrial Park
160 Gamma Drive
Pittsburgh, Pa. 15238

Set Products (Canada) Ltd.
Scarborough, Ont. M1E 1K7

Sika Corporation
P. O. Box 297
Lyndhurst, N.J. 07071

Stebbins Engineering
and Manufacturing Company
363 Eastern Boulevard
Watertown, N.Y. 13601

Sternson Limited
Brantford, Ont. N3T 5N1

Stonhard Company
One Park Avenue
Maple Shade, N.J. 08052

Summitville Tiles, Inc.
Summitville, Ohio 43962

U. S. Stoneware Company
5300 East Tallmadge Avenue
Akron, Ohio 44309

Watkins Brick Company
P. O. Drawer B
Ensley Station
Birmingham, Ala. 35218

Mortars, Toppings, and Overlays Category

Ameron Protective Coatings Div
Colgate Avenue
Buffalo, N.Y. 14220

Atlas Minerals and Chemicals Inc.
Farmington Road
Mertztown, Pa. 19539

C. C. Chemicals
Thornhill, Ont.

Ceilcote Canada Ltd.
Mississauga, Ont.

Ceilcote Company
140 Sheldon Road
Berea, Ohio 44017

Charlotte Chemical Lab. Inc.
5046 Old Pineville Road
Charlotte, N.C. 28210

Corrosion Engineering Div.
Pennwalt Corp.
3 Parkway
Philadelphia, Pa. 19102

Madison Chemical Industries Ltd.
Milton, Ont.

Maurice A. Knight Company
P. O. Box 109
Akron, Ohio 44309

Mulco Inc.
St. Hubert, Que. J4T 3K3

Pocono Fabricators
Div. of Patterson-Kelley-Harsco
Corporation
Box 458
East Stroudsburg, Pa. 18301

Plibrico Company
1800 Kingsbury Street
Chicago, Ill. 60614

Saureisen Cements Company
RIDC Industrial Park
160 Gamma Drive
Pittsburgh, Pa. 15238

Set Products (Canada) Ltd.
Scarborough, Ont. M1E 1K7

Sika Corporation
P. O. Box 297
Lyndhurst, N.J. 07071

Stebbins Eng. and Mfg. Co.
363 Eastern Boulevard
Watertown, N.Y. 13601

Sternson Limited
Brantford, Ont. N3T 5N1

Stonhard Company
One Park Avenue
Maple Shade, N.J. 08052

17. Sheet Rubber (Natural and Synthetic)

Ameron Protective Coatings Div.
201 North Berry Street
Brea, Calif. 92621

Atlas Minerals and Chemicals Inc
Farmington Road
Mertztown, Pa 19539

Boston Woven Hose &
Rubber Division
American Biltrite Rubber Co., Inc
P. O. Box 1071
Boston, Mass. 02103

Ceilcote Company
140 Sheldon Road
Berea, Ohio 44017

Exxon Chemical Company USA*
P. O. Box 3272
Houston, Tex. 77001

Gates Engineering Company, Inc.
100 South West Street
Wilmington, Del 19899

Gates Rubber Company
999 South Broadway
Denver, Colo. 80217

Goodall Rubber Company
P. O. Box 8237
Trenton, N.J. 08650

B. F. Goodrich Eng. Prod. Group
500 South Main
Akron, Ohio 44318

Goodyear Tire & Rubber Co., Inc.
Industrial Products Division
P. O. Box 52
Akron, Ohio 44309

Heil Process Equipment Corporation
12950 Elmwood Avenue
Cleveland, Ohio 44111

Uniroyal, Inc.
World Headquarters
Production Information Center
Middlebury, Conn. 06749

U. S. Stoneware Company
5300 East Tallmadge Avenue
Akron, Ohio 44309

18. Resin Sheets

Ameron Protective Coatings Division
201 North Berry Street
Brea, Calif. 92621

Atlas Minerals and Chemicals Inc.
Farmington Road
Mertztown, Pa. 19539

Carboline Company
350 Hanley Industrial Court
St. Louis, Mo. 63144

Ceilcote Company
140 Sheldon Road
Berea, Ohio 44017

*Provides the rubber raw material only.

B F Goodrich Eng Products Group
500 South Main
Akron, Ohio 44318

Heil Process Equipment Corporation
12950 Elmwood Avenue
Cleveland, Ohio 44111

Maurice A Knight Company
P. O. Box 109
Akron, Ohio 44309

Rulon Company
Div. of Colonial Industries, Inc.
Linwood & Pine Avenues
Maple Shade, N.J. 08052

Sonneborn Building Products
Division of Contech, Inc.
7711 Computer Avenue
Minneapolis, Minn. 55435

U. S. Rubber Company
Royalite Plastic Products
2634 North Pulaski Road
Chicago, Ill. 60639

U. S. Stoneware Company
5300 East Tallmadge Avenue
Akron, Ohio 44309

Canadian Manufacturers of:

Polyethylene Sheet

Federal Plastics Mfg. Ltd.
5100 Fisher Street
Montreal, Que. H4T 1J5

Plastiques GM Ltée
3655 Boulevard Losch
St. Hubert, Que. J3Y 5T7

Plastalene Corporation Mfg. Ltd.
675 Simonds Street
Granby, Que. J2J 1C2

Polyvinyl Chloride Sheet

Borden Chemical
Div. of the Borden Co. Ltd.
595 Coronation Drive
West Hill, Ont. M1E 4R9

Canadian General Tower Ltd.
52 Middleton Street
P. O. Box 160
Cambridge, Ont. N1R 5T6

Goodyear Canada Inc.
Plastic Films Division
450 Kipling Avenue
Toronto, Ont. M8Z 5E1

Stauffer Chemical Company
of Canada Ltd.
207 New Toronto Street
Toronto, Ont. M8V 2G2

TCF of Canada Limited
P. O. Box 159
Cornwall, Ont. K6H 5S9

ABS Sheet

Federal Plastics Mfg Ltd.
Montreal, Que H4T 1J5

Plastalene Corporation Ltd.
Granby, Que. J2C 1C2

Plastiques GM Ltée
3655 Boulevard Losch
St. Hubert, Que. J3Y 5T7

Acrylic Sheet

Acrylco Mfg Ltd.
711 Derwent Way, Annacis Island
New Westminster, B.C. V3M 5P9

Chemacryl Plastics Ltd.
73 Richmond Street, W. - Suite 500
Toronto, Ont. M5H 2A2

Genesta Manufacturing Ltd.
551 Imperial Road
Guelph, Ont. N1H 6R1

K-S-H Canada Ltd.
1810 Steeles Avenue E.
Bramalea, Ont. L6T 1A7

Plastalene Corporation Ltd.
675 Simonds Street
Granby, Que. J2J 1C2

Rohm and Haas Canada Ltd.
2 Manse Road
West Hill, Ont. M1E 3T9

Fiberglass-Reinforced Plastic Sheet

Atlas Asbestos Company Ltd.
5600 Hochelaga Street
Montreal, Que. H1N 1W1

Graham Products Limited
Box 2000
Inglewood, Ont. L0N 1K0

Polystyrene Sheet

Federal Plastics Mfg. Ltd.
5100 Fisher Street
Montreal, Que. H4T 1J5

Plastalene Corporation Ltd.
675 Simonds Street
Granby, Que. J2J 1C2

Polypropylene Sheet

Federal Plastics Mfg. Ltd.
5100 Fisher Street
Montreal, Que. H4T 1J5

Plastalene Corporation Ltd.
675 Simonds Street
Granby, Que. J2J 1C2

19. Lead Sheet

Commercially available locally.

20. Glass

Ceramco, Inc. Chemists
171 Ridge Street
Newark, N.J. 07104

Corning Glass Works
Technical Products Division
80 Houghton Park
Corning, N.Y. 14830

Pfaudler Company
Div. of Ritter Pfaudler Corp.
West Avenue & Clark Street
Rochester, N.Y. 14630

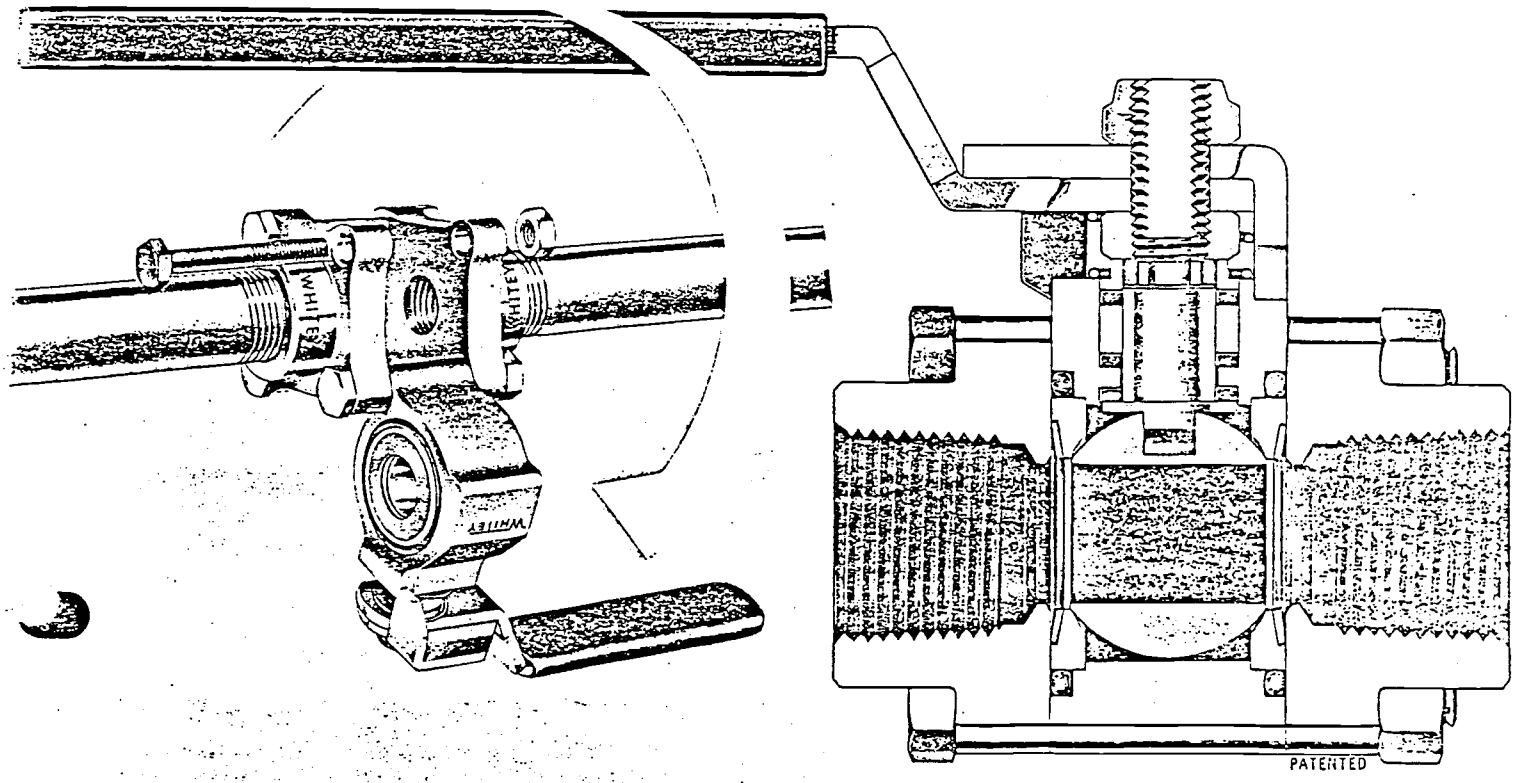
PPG Industries, Inc.- Glass Div.
One Gateway Center
Pittsburgh, Pa. 15222

Owens-Illinois, Inc.- Kimble Div.
P. O. Box 1035
Toledo, Ohio 43666

APPENDIX D-8

VALVE SPECIFICATIONS

WHITEY® "60" SERIES SWING-OUT BALL VALVES



PURPOSE

The WHITEY "60" Series Swing-Out Ball Valves fill the need for compact, reliable, full flow ball valves adaptable to a variety of piping systems. The new three-piece design offers a simple swing-out feature for fast, easy, low-cost maintenance. The special seat design provides leak-tight sealing at both high and low pressures.

APPLICATIONS

Applications are found in all types of on-off service where high capacity and quick, positive shut-off are required. Chemical plants, refineries, power plants, laboratories and most manufacturing plants are typical users of the WHITEY "60" Series Swing-Out Ball Valves. Applications in the process industries include latex lines, acid lines, treated water lines, inert gas lines and glue lines. Other industrial applications include natural gas, steam lines, paint lines, sprinkler systems, use on tankers, gas manifolds, and hydraulic and air lines of all types.

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OPERATION

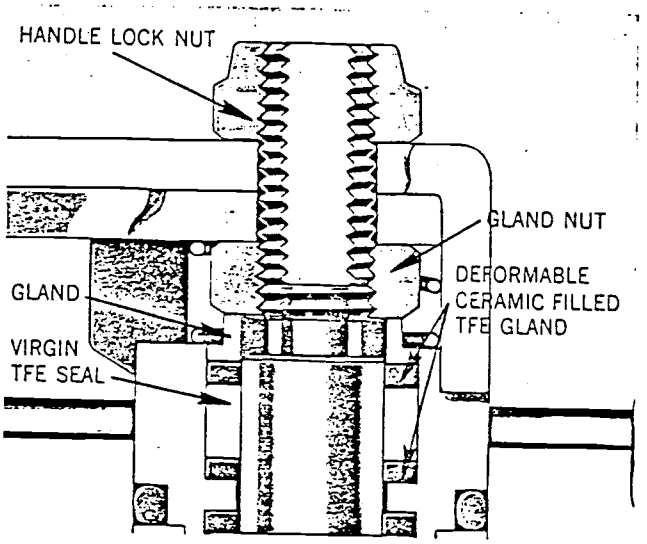
Rotate the directional handle 1/4 turn from full open to full leak-tight closure. Operating torque is low at all service pressures. The rugged handle stops against the body to maintain alignment of the ball and achieve full flow through the valve. Pneumatic operators, both double acting and spring return models, provide remote actuation.

SPECIAL FEATURES

Engineered for Easy Maintenance

Fast, Swing-out Design — Maintenance is quick and simple and can be accomplished without removing the valve from the system. Remove the one black bolt and loosen the other three nuts. Swing the body (center section) out and perform the required maintenance of the seats or cleaning. Swing the body back in and replace the black bolt and tighten all nuts. Note that the flange faces are flat so all maintenance can be done without moving the piping. Each valve is a union. (Complete maintenance information is covered on the "Service Instructions" sheet supplied with each valve).

WHITEY® "60" SERIES SWING-OUT BALL VALVES



Adjustable Three-piece Stem Packing — The virgin TFE packing seal is supported top and bottom by ceramic filled TFE deformable glands. This system prevents extrusion of the virgin TFE seal and promotes long cycle life. The packing is easily adjusted with the valve on-stream. Simply hold the stem with the handle, loosen the lock nut and adjust the gland nut. Retighten the lock nut.

Seal Service Kit — WHITEY Seal Service Kits can be used on either brass or stainless steel valves to reduce user inventories. This kit contains replacements for all wearing parts; the ball seats with coned disc springs, stem packing and flange seals. A spare flange nut is included for convenience. Other spare parts are available upon request.

Engineered for Flexibility

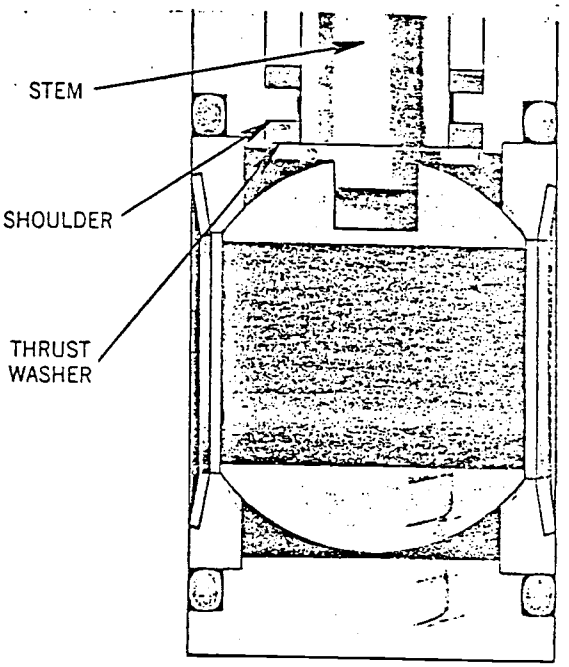
Variety of End Connections — "60" Series valves are available with a variety of end connections. Several sizes of pipe and tube socket weld ends are standard. The three-piece swing-out design is ideally suited to welded systems. The center body section, including all sealing elements can be easily removed during welding to prevent heat damage. After welding the swing-out design allows easy maintenance.

VALVE SERIES	TYPE OF END CONNECTION		
	Female NPT	Pipe Socket Weld	SWAGELOK and Tube Socket Weld
"63"	1/2"	1/2"	1/2", 3/4"
"65"	3/4", 1"	3/4", 1"	1"

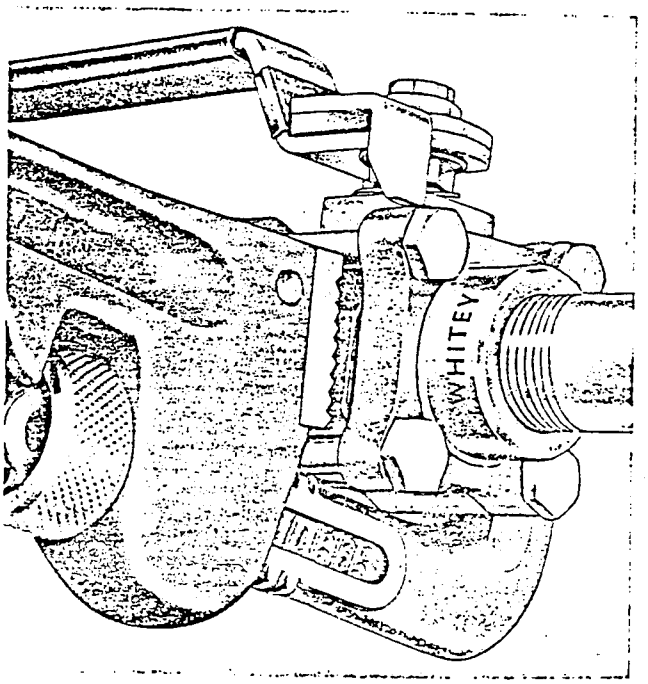
Choice of Seat Materials — TFE seats are standard in all valves. Delrin seats are also available in "63" Series valves for use in applications such as high pressure block valves. The Delrin offers better resistance to cold flow at higher pressures.

Air Operated Models — 90° Double Acting Air Operators are available for all "60" Series Swing-Out Ball Valves. Additionally, 90° Spring Return, either Normally Open or Normally Closed operators are available for the "63" Series Valves. (See Air Operated Ball Valves data sheet in Air Operated Valves subsection of Master Catalog Binder.)

Engineered for Safety

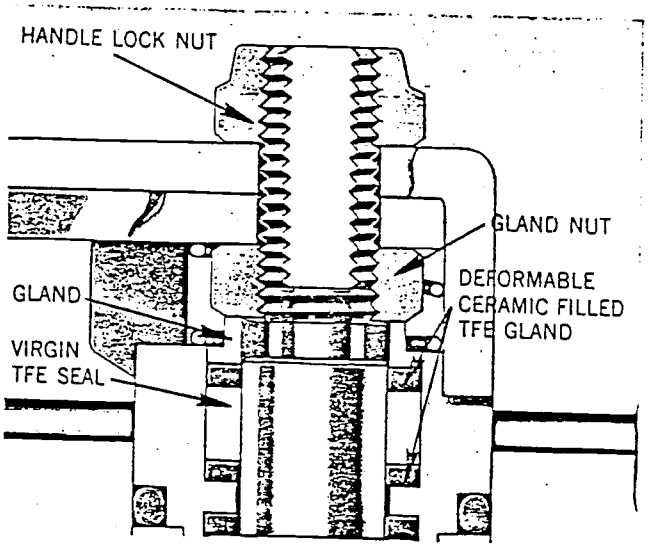


Blowout Proof Stem — The stem is installed from the inside of the body. A shoulder on the stem rides against a thrust washer which is supported by a shoulder in the body. Thus the stem cannot be blown out by internal pressure surges, nor can it be removed accidentally by removing external nuts or fasteners. This provides an extra margin of safety in critical systems.



Clamping Bolts Exposed for Safety — High tensile bolts clamp the flanges to the body. Three of the plated bolts are exposed to permit inspection for environmental corrosion. Of the three, only the **black bolt** need be removed when maintenance is required. The exposed bolts are protected from installation damage by a wrench pad on the body.

WHITEY® "60" SERIES SWING-OUT BALL VALVES



Adjustable Three-piece Stem Packing — The virgin TFE packing seal is supported top and bottom by ceramic filled TFE deformable glands. This system prevents extrusion of the virgin TFE seal and promotes long cycle life. The packing is easily adjusted with the valve on-stream. Simply hold the stem with the handle, loosen the lock nut and adjust the gland nut. Retighten the lock nut.

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Engineered for Flexibility

Variety of End Connections — "60" Series valves are available with a variety of end connections. Several sizes of pipe and tube socket weld ends are standard. The three-piece swing-out design is ideally suited to welded systems. The center body section, including all sealing elements can be easily removed during welding to prevent heat damage. After welding the swing-out design allows easy maintenance.

VALVE SERIES	TYPE OF END CONNECTION		
	Female NPT	Pipe Socket Weld	SWAGELOK and Tube Socket Weld
"6[illegible]"	1/2"	1/2"	1/2", 3/4"
"65"	3/4", 1"	3/4", 1"	1"

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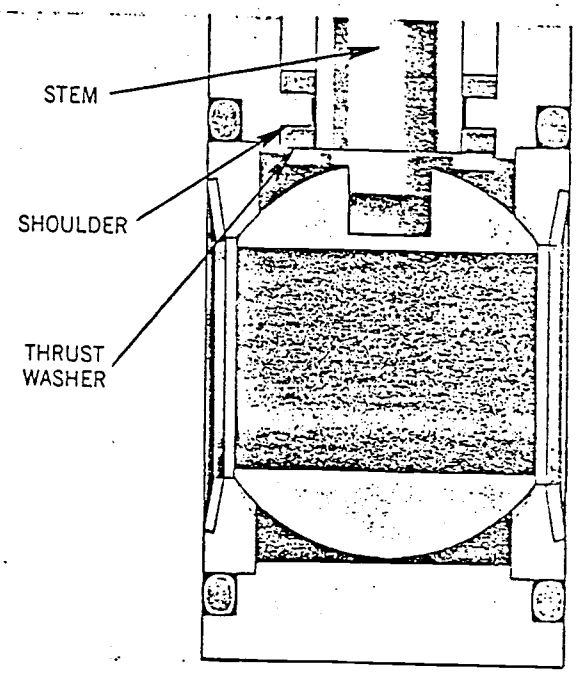
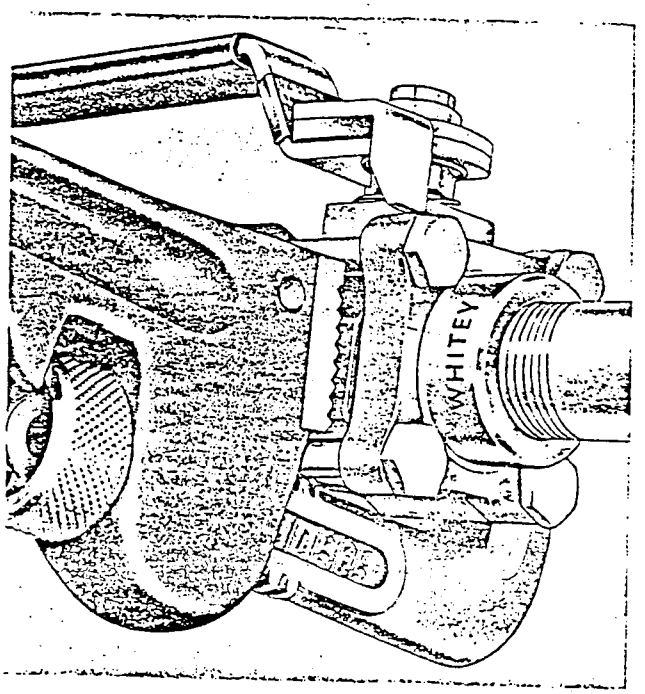
Engineered for Safety



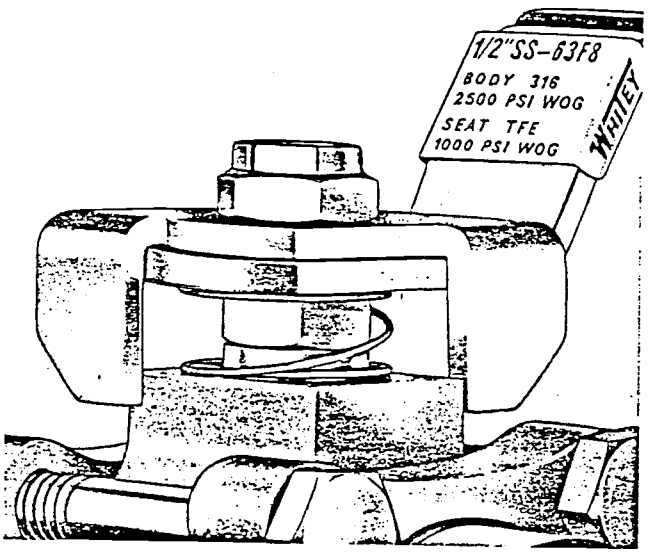
Blowout Proof Stem — The stem is installed from the inside of the body. A shoulder on the stem rides against a thrust washer which is supported by a shoulder in the body. Thus the stem cannot be blown out by internal pressure surges, nor can it be removed accidentally by removing external nuts or fasteners. This provides an extra margin of safety in critical systems.



Clamping Bolts Exposed for Safety — High tensile bolts clamp the flanges to the body. Three of the plated bolts are exposed to permit inspection for environmental corrosion. Of the three, only the black bolt need be removed when maintenance is required. The exposed bolts are protected from installation damage by a wrench pad on the body.

WHITEY® "60" SERIES SWING-OUT BALL VALVES

Color Coded Handles — Black vinyl grips are standard. Four other bright colors are available for system identification; red, yellow, green and blue.



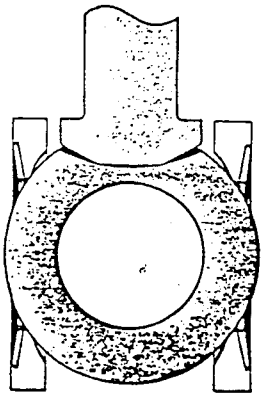
Grounded Stem — A stainless steel spring assures electrical contact between the stem and body, preventing sparks which can occur in ungrounded valves. This is standard on all "60" Series valves.

Engineered for Reliability

Maximum Flow Capacity — The compact valves offer the largest possible orifices consistent with system requirements. Flow restriction is minimized and the valves may be rodded out for easy cleaning.

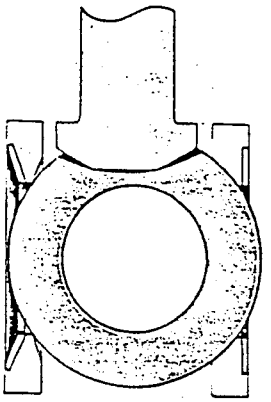
Three Piece Body — The three body pieces are machined from high quality extruded bar stock, providing the greatest material strength and safety margins.

Unique Seat Design — The seats in the WHITEY "60" Series valves are supported by a small stainless steel coned disc spring. This provides a positive sealing force at low pressure and elasticity to the sealing system. It also resists creep or cold flow of the seal member.



LOW PRESSURE OR VACUUM

At low pressure, the spring provides enough force to form a narrow line contact seal between the ball and the plastic seat. Both upstream and downstream seats are sealed. Operating torque is low and wear is minimized because of the low sealing force.



HIGH PRESSURE

At high pressure, the spring supporting the downstream seat flexes so that the entire seal area of the plastic seat supports the high force generated by pressure on the ball. Since the upstream plastic seat lightly contacts the ball, wear and operating torque are minimized.

This unique seat design results in a ball valve seat which seals reliably at all pressures and automatically compensates for wear and thermal expansion. This design overcomes the weakness of ordinary ball valve seats caused by poor elasticity and high creep of plastics. The standard TFE seating surfaces provide the outstanding characteristics of low friction and universal chemical resistance.

Contained Flange Seals — The flanges are sealed to the center body section with O-Rings which are fully contained and seal independently of the ball seat.

Self-lubricating Thrust Washer — The stem rides on a Vespel thrust washer, providing lower operating torques and longer life.

Broad Temperature Range — The valve may be used at system temperatures from -20°F to +450°F. (See Pressure vs Temperature Curve).

100% Factory Tested — Each valve is individually tested after assembly for leak tightness at the ball seats, stem packing and at all flange joints.

Special Packaging — All valves are sealed in polyethylene bags to prevent dirt and contamination from entering the valves.

MATERIALS

PART	316 SS VALVES	BRASS VALVES
Body, Ball, Stem, Gland	316 SS	Brass
Flanges	316L SS	Brass
Stem Packing, Ball Seats	TFE (std.), Delrin optional in "63" Series valves	
Deformable Glands	Ceramic filled TFE	
Stem Thrust Washer	Vespel	
Coned Disc Springs, Grounding Spring	316 SS	
Flange Seals	Viton O-Rings	
Flange Bolts and Nuts, Gland Nut, Handle Nut, Handle and Stop Plate	Steel, cadmium plated*	
Nameplate	302 SS	
Handle Grip	Vinyl	

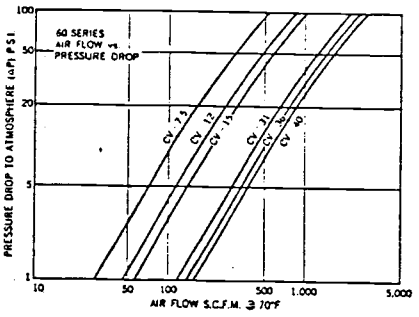
WHITEY® "60" SERIES SWING-OUT BALL VALVES

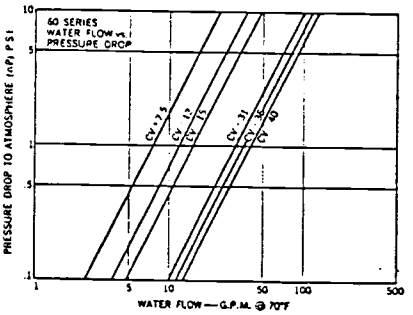
BODY AND FLANGE ASSEMBLY RATINGS					
Series	Material	Working Pressure @ 100°F Max. (PSI)	Hydrostatic Test Pressure* Max. (PSI)	Burst Pressure Min. (PSI)	Vacuum (Torr)
63, 65	Brass	1500	2250	6000	10^{-3}
	316 SS	2500	3750	10,000	10^{-3}

*Hydrostatic test pressure must be applied with the valve half open.

SEAT RATINGS							
Series	Seat Material	Flange Seal Material	Working Pressure Max. 100°F PSI†	Saturated Steam or Water Service	Vacuum Torr	Temperature Range °F††	
						316 SS	Brass
63, 65	TFE	Viton	1000	150 psi Max. Steam	1	-20 to 450	-20 to 400
63	Delrin	Viton	2500	140°F Water	1	-20 to 180*	

†Valve seat rating is the maximum pressure differential across the valve, fully closed.
††Refer to graph of pressure-temperature ratings.
*The maximum service temperature of Delrin is often limited by the process fluid; contact the factory for specific applications.





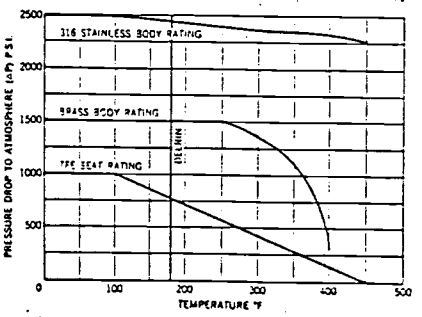
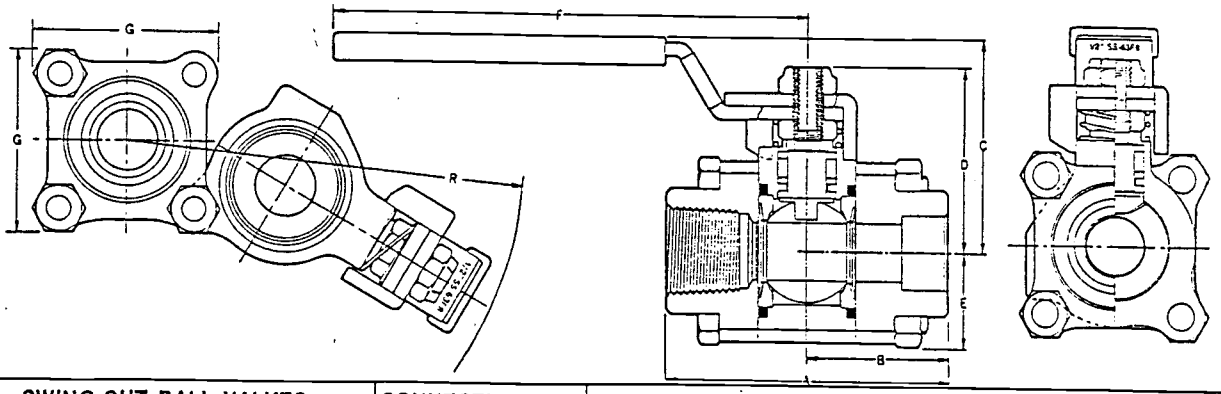


TABLE OF DIMENSIONS



SWING-OUT BALL VALVES			CONNECTION SIZE	DIMENSIONS							
Catalog Number*	Orifice (inches)	Flow Coefficient Cv	Inlet and Outlet	A	B	C	D	E	F	G	R
-63F8	0.516	12	1/2 Female NPT	2-11/16	1-11/32	2-1/16	1-3/4	7/8	4-9/16	1-3/4	3-13/16
-63SW8P	0.516	15	1/2 PSW								
-63SW8T	0.406 (port)	7.5	1/2 TSW								
-63SW12T	0.516	13.6	3/4 TSW								
-65F12	0.875	31	3/4 Female NPT	3-19/32	1-13/16	2-15/16	2-19/32	1-3/16	5-7/8	2-3/8	5-3/8
-65F16	0.875	38	1" Female NPT								
-65SW12P	0.875	36	3/4 PSW								
-65SW16P	0.875	42	1" PSW								
-65SW16T	0.875	40	1" TSW								

*For a complete ordering number, add B for brass or SS for 316 stainless steel as a prefix to the catalog number. Example: B-63F8, SS-65F12

YOUR LOCAL SALES & SERVICE REPRESENTATIVE

DELRIN, VESPEL, VITON — T.M. DuPont

APPENDIX D-9

ION EXCHANGE COLUMN SPECIFICATIONS

PUROLITE®

Technical Data
NRW 37 MIXED BED

PRODUCT DESCRIPTION

Purolite's nuclear resins are processed in the United States under the most exacting specifications. These resins are specially purified with high percent conversions to their regenerated form and closely controlled particle sizes. These resins in most cases meet specifications such as the Westinghouse Electric Corporation Specification Number 53141AC and the General Electric Corporation (Boiling Water Reactor) Specification. Base hardnesses in all our products average over 400 grams in the regenerated forms and sphericities are all over 95%. All of Purolite's nuclear products have whole perfect beads over 95% with most closer to 100%.

Purolite's nuclear products are used in ultra-pure water, radiation waste, pharmaceuticals and condensate polishing. Our mixed bed resins are generally used in polishers following other types of water processing. Our high grade of nuclear resins insure that the water processed is in fact the highest quality known to man (18.3 meg ohm)*

Purolite NRW 37 consists of A-600 (strong base type 1 anion) and C-100 (strong acid cation) both in the regenerated form mixed to a 1:1 chemical equivalent. Other ratios are available upon request. Purolite mixed bed resins can be used for regenerative or non-regenerative (cartridges) systems. Purolite nuclear resins are processed without declumping agents to insure that the quality obtained is nothing less than the best.

Purolite NRW-37 is available both in amber or black cations.

*Depends upon water analysis and equipment used.

Typical Chemical and Physical Characteristics

Functional Structure
Cation ..... SO_3H^+ (Hydrogen form sulfonated polystyrene copolymer
Anion ..... $R_4N^+ OH^-$ (Hydroxyl form strong base alkyl quaternary ammonium polystyrene (copolymer)

Physical Appearance ..... Clear Spherical Beads
Ionic Form (as shipped) ..... H/OH
Screen Size U.S. Std. Mesh (Wet) ..... -16 +50
Particle Size
Limitation ..... Not more than 2% +16 mesh
Not more than 1% -50 mesh
Volume Ratio (Typical) ..... 1.5 parts Purolite A-600 anion
1.0 parts Purolite C-100 cation
Total Capacity (Volumetric)
Cation ..... 1.9 meq./ml. min.
Anion ..... 1.4 meq./ml. min.
Column Capacity 0.65 meq/ml (14 Kgr/cu.ft.) min.
Standard Packaging ..... 5 cu. ft. double polyethylene lined fiber drums

Heavy Metals Content as ppm by weight of dry resin
Iron (Fe) ..... 100 ppm
Copper (Cu) ..... 50 ppm
Lead (Pb) ..... 50 ppm
Percent Conversion to Ionic Form
Cation ..... H^+ = 98% min. (or as requested)
Anion ..... OH = 90% min. (or as requested)
Cl = 3% Max. (or as requested)
CO_3 = 10% max.
Moisture Content as Shipped 60% max.
pH Range (Stability) ..... 0 to 14
Approximate Shipping Weight .45 lbs./ft.^{3} (720 g/l)
Maximum Operating Temperature
Non-Regenerative bed ..... 212°F (100°C)
Regenerative bed ..... 140°F (60°C)
Operating Flow Rate .. 5-7 gpm/sq.ft. (higher rates may be used for polishing bed units)

Purity of Deionized Water Ultra-high purity water greater than 10 meg. ohm resistance usually ranging to 18.3 meg. ohm equivalent to 0.1 $\mu S\ cm^{-1}$ to 0.055 $\mu S\ cm^{-1}$ respectively

PUROLITE The Purolite Company
Division of Bro-tech Corporation 150 Monument Road, Bala Cynwyd, PA 19004

SPECIFIC CONDUCTANCE, RESISTANCE, APPROXIMATE ELECTROLYTE CONTENT

For Deionized or Distilled Water at 78°F. or 25°C.

Specific Cond. In Micromhos	Specific Resistance In Ohms	Approximate Electrolyte Content, ppm					
		as NaCL	as $CaCO_3$	as NaOH	as $CaCO_3$	HCl	as $CaCO_3$
0.1	10,000,000	0.04	0.03	0.01	—	0.01	—
0.2	5,000,000	0.08	0.07	0.03	0.04	0.02	0.03
1	1,000,000	0.4	0.34	0.17	0.21	0.09	0.12
2	500,000	0.8	0.68	0.33	0.41	0.18	0.25
4	250,000	1.6	1.35	0.66	0.83	0.35	0.48
6	166,000	2.5	2.10	1.0	1.25	0.52	0.71
8	125,000	3.2	2.70	1.4	1.75	0.70	0.96
10	100,000	4.0	3.40	1.8	2.25	0.86	1.18
20	50,000	8.0	6.80	3.2	4	1.6	2.19
30	33,333	14.0	12.00	5	6	2.6	3.5
40	25,000	19.0	16.00	6	7.5	3.4	4.7
50	20,000	24.0	20.00	8	10	4.2	5.8
60	16,666	28.0	24.00	9.5	12	5.2	7.1
70	14,286	33.0	28.0	11	14	6.0	8.2
80	12,500	38.0	32.0	13	16	6.8	9.3
90	11,111	43.0	36.0	14	17.5	7.6	10.4
100	10,000	50.0	43.0	16	20	8.5	11.6
200	5,000	100.0	85.0	31	39	17	23

Purolite carries a complete range of Gel and Macroporous Cation Exchangers. These include:

Purolite C-100 a high capacity grade Gel Cation Exchanger
Purolite C-100H a strong acid Cation, Hydrogen Form
Purolite C-100 x 10 a high capacity premium grade 10% Cross Linked Cation Exchanger
Purolite C-100FM a fine mesh Cation for water softening
Purolite C-105 a weak acid Cation Resin
Purolite C-150 a strong acid Cation Macroporous Exchanger
Purolite A-100 a Macroporous weak base Anion Exchanger
Purolite A-110 a weak base Condensation Anion
Purolite A-300 a strongly basic Type II Anion Exchanger
Purolite A-300E a Type II Gel Anion Exchanger with no taste or odor
Purolite A-400 a strongly basic Type I Porous Gel Anion Exchanger
Purolite A-444 a Porous Type I Gel Organic Scavenger
Purolite A-500 a Macroporous Type I strongly basic Anion Exchanger
Purolite A-500P a Macroporous Type I Organic Scavenger
Purolite A-510 a Macroporous Type II Anion Exchanger
Purolite A-600 a strongly basic Type I Anion Exchanger
Purolite A-850 a strongly basic Type I Acrylic Exchanger
Purolite NRW-37 a Nuclear Mixed Bed Resin
Purolite NRW-100 a Nuclear Cation Resin
Purolite NRW-400 a Nuclear Porous Anion Resin
Purolite NRW-600 a Nuclear Anion Resin

Purolite also has a complete line of Semiconductor Grade Resins. For a complete list of Purolite products, please contact our national office.

The Technical Data given herein are based on extensive laboratory testing and field results. In applying the data on a commercial scale, allowance should be made for possible mechanical or hydraulic deficiency of the equipment in which the Ion exchangers are used. For further information, please contact our national office.

PUROLITE

Purolite Company Division of Bro-Tech Corporation,
150 Monument Rd., Bala Cynwyd, Pennsylvania 19004 • 800-343-1500 • 215-668-9090
Telex 291718

PUROLITE Technical Data

A-600

Anion Exchange Resin
Strong Base, Type I

PRODUCT DESCRIPTION

Purolite A-600 is a strongly basic Type I quaternary ammonium anion exchange resin with a styrene-divinylbenzene copolymer matrix. A-600 can be used in all types of deionization systems and is recommended for multibed or mixed bed use. A-600 has a high capacity for silica removal and can produce high quality water practically silica free. This strong base resin has good temperature stability at high temperatures which are required to minimize silica leakage.

Purolite A-600 has excellent physical stability with bead hardness over 500 grams average and whole clear bead counts of 95% minimum. A-600 removes weak acids such as silica and carbonic as well as strong acids, sulfate and chloride.

Typical Chemical and Physical Characteristics

Polymer Structure	Styrene divinylbenzene
Matrix Structure	Gel
Active Group	$R(CH_3)_3N^+$
Ionic Form	Cl
Character	Strong Base
Physical Appearance	Amber Spheres
Particle Size	+16 mesh<2%, -50 mesh<1%
Total Capacity	1.5 meq./ml, min. Volumetric 3.7 meq./gm, min. Weight
Screen Size, U.S.Std. Mesh (Wet)	16-50
Swelling (Cl—OH)	20%
Water Retention	43-48%
pH Limitations	None
Shipping Weight	44 lbs./ft.^{3}(704 g/l)
Solubility	Insoluble in all common solvents
Whole Bead Count	95% minimum
Standard Packaging	5 cu.ft. double polyethylene-lined fiber drums

Application Characteristics

Maximum Operating Temperature	
OH form	140°F (60°C)
Salt form	212°F (100°C)
Minimum Bed Depth	24" (60cm)
Backwash Flowrate	1.5-2.5 gpm/sq. ft.
Backwash Expansion	50-75%
Service Flowrate	1-5 gpm/cu.ft.
Regenerant	NaOH
Regeneration Flowrate	0.2-0.5 gpm/cu.ft.
Regenerant Contact Time	30/60 min.
Slow Rinse Rate	0.2-0.5 gpm/cu.ft.
Fast Rinse Rate	2 gpm/cu.ft.

Influent Limitations

Maximum Free Chlorine	0.1 ppm
Maximum Turbidity	5 A.P.H.A. Units
Maximum Iron and Heavy Metal	0.1 ppm

SHIPPING & STORAGE

A-600 is a strongly basic anion shipped in the chloride form. By shipping in the chloride form, A-600 can be stored indefinitely with the following precautions:

- Protect against drying
- Keep from freezing and thawing repeatedly
- Keep out of direct sunlight

PRESSURE DROP

The pressure loss when passing a solution through a bed of A-600 when used in a column operation, is directly related to the rate of flow and the temperature of the solution. This data is based on clean water and new resin. Any particulate matter that is filtered out by the ion exchange media will cause additional pressure drop.

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CAPACITY and LEAKAGE—See A-400 Product Bulletin

PHYSICAL STABILITY

Purolite A-600 not only has good bead strength but excellent bead integrity, a minimum of 95%. Due to these attributes, A-600 demonstrates a high resistance to attrition from all stresses, physical, thermal and osmotic. Greater physical stability means longer life and easier operation.

REGENERATION FOR DEIONIZATION

Regenerant..... Sodium Hydroxide
Level .....Dependent on Capacity Desired
Concentration 2-4%
Rinse Requirement .....60 gals./cu. ft.

Figure 1.
Bed Expansion vs. Backwash Flow Rate
Purolite A-600

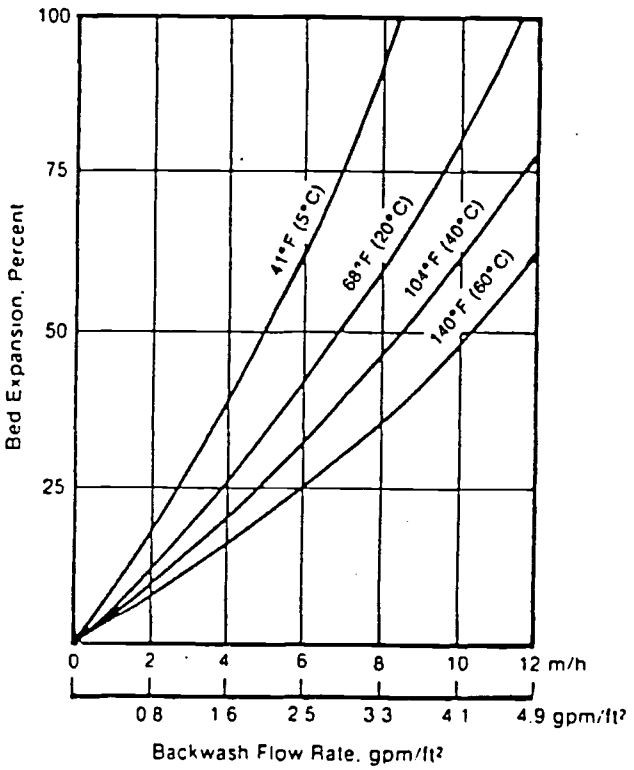
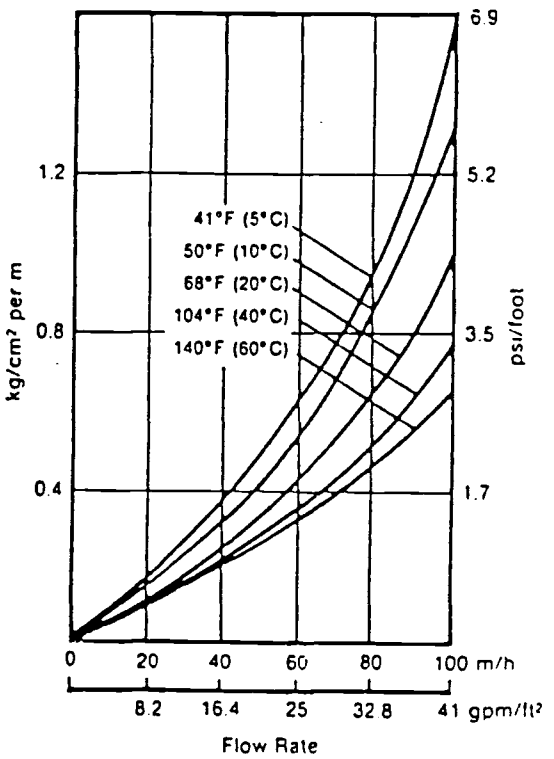


Figure 2.
Pressure Drop vs. Flow Rate
Purolite A-600



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Purolite also has a complete line of Semiconductor Grade Resins. For a complete list of Purolite products, please contact our National office.

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PUROLITE

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150 Monument Rd., Bala Cynwyd, Pennsylvania 19004 • 800-343-1500 • 215-668-9090
Telex 291718

PUROLITE

Technical Data
C-100H
(Hydrogen Form Purolite C-100—C-101)

Strong Acid Cation
Hydrogen Form

PRODUCT DESCRIPTION

Purolite C-100H is a premium grade cation exchanger that can be used in water demineralization. C-100H is produced exactly the same as Purolite C-100, using a crosslinked styrene divinylbenzene polymer matrix with 8% crosslinking. Bead stability and a minimum of 95% whole clear beads make C-100H a premium grade gel without the added cost of buying an upgraded cation product. The data presented herein are applicable for hydrogen cycle cation exchange operation only. For sodium cycle information see C-100.

Typical Chemical and Physical Characteristics

Polymer Structure	Polystyrene crosslinked with divinylbenzene
Functional Groups	$R—SO_3^-$
Physical Appearance	Clear Spherical Beads
Ionic Form (as shipped)	Hydrogen
Screen Size, U.S. Std. Mesh (Wet)	16-45
Particle Size Range	+16 mesh<5%, -40 mesh<1%
Water Retention	49-55%
pH Limitations	None
Temperature Limitations	280°F (140°C)
Whole Clear Beads	95% minimum
Shipping Weights	50 lbs./ft.^{3}, (800 grams/liter)
Total Capacity	1.9 meq/ml. minimum Volumetric 4.9 meq/gm. minimum Weight
Standard Packaging	5 cu. ft. double polyethylene-lined fiber drums
D.V.B. Content	8%
Color	Black or Amber

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Division of Bro-tech Corporation 150 Monument Road, Bala Cynwyd, PA 19004

Section V — Reactivity Data

Stability			Conditions to Avoid
	Unstable		
	Stable	X	AVOID TEMPERATURES OVER 220°C (428°F)

Incompatability (Materials to Avoid)
AVOID CONTACT WITH CONCENTRATED NITRIC ACID, OR STRONG OXIDIZING AGENTS.

Hazardous Decomposition or Byproducts
SO_2, SO_3, CO, CO_2, STYRENE MONOMER, DI-VINYL BENZENE.

Hazardous Polymerization			Conditions to Avoid
	May Occur		
	Will Not Occur	X	

Section VI — Health Hazard Data

Route(s) of Entry: N/A Inhalation? Skin? Ingestion?

Health Hazards (Acute and Chronic)

Carcinogenicity: N/A NTP? IARC Monographs? OSHA Regulated?

Signs and Symptoms of Exposure

Medical Conditions Generally Aggravated by Exposure EYE CONTACT: LIKE OTHER FOREIGN BODIES, PARTICLES MAY CAUSE MECHANICAL IRRITATION OF THE EYE.

Emergency and First Aid Procedures EYE CONTACT: FLUSH WITH LARGE AMOUNTS OF WATER FOR AT LEAST 15 MINUTES. CONSULT PHYSICIAN IF IRRITATION PERSISTS.

Section VII — Precautions for Safe Handling and Use

Steps to Be Taken in Case Material Is Released or Spilled
RESIN BEADS ON FLOOR MAY MECHANICALLY CAUSE FLOOR TO BE SLIPPERY. USE CARE TO AVOID FALLS. SWEEP UP AND TRANSFER TO CONTAINERS FOR RECOVERY OR DISPOSAL.

Waste Disposal Method
THIS MATERIAL CAN BE DISPOSED OF AS ORDINARY TRASH.

Precautions to Be Taken in Handling and Storing
KEEP DRUMS AND PLASTIC BAGS SEALED TO PREVENT DRYING OR MOISTURE LOSS.

Other Precautions
STORE BELOW 49°C (120°F) AND ABOVE 0°C (32°F)

Section VIII — Control Measures

Respiratory Protection (Specify Type)
NONE

Ventilation			
	Local Exhaust	NORMAL PLANT VENTILATION	Special
	Mechanical (General)		Other

Protective Gloves | Eye Protection SAFETY GLASSES (ANSI z87.1)

Other Protective Clothing or Equipment

Work/Hygienic Practices
CLEANLINESS IS RECOMMENDED.

APPENDIX D-10

HEATER SPECIFICATIONS

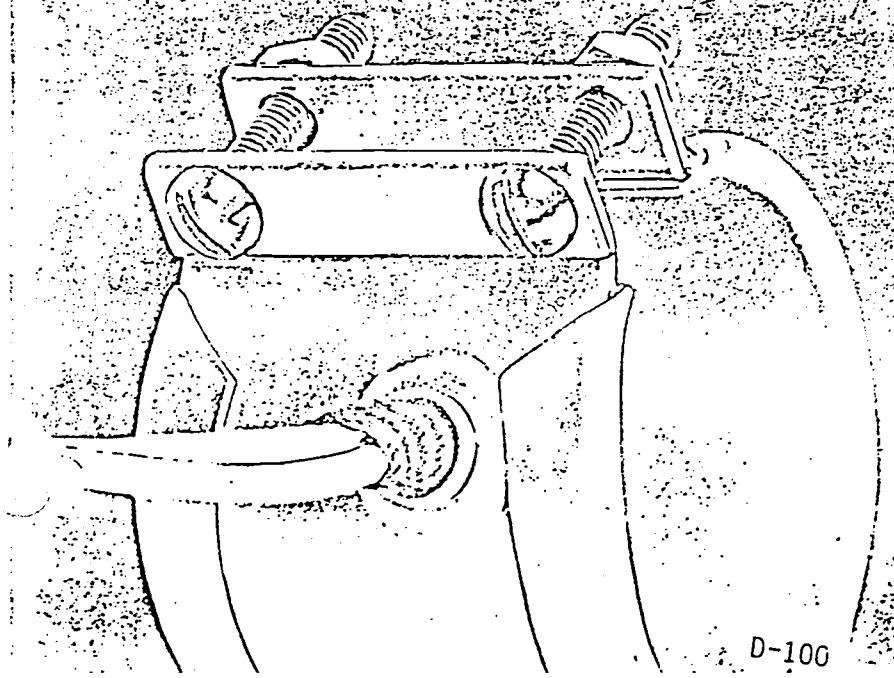
HEATERS

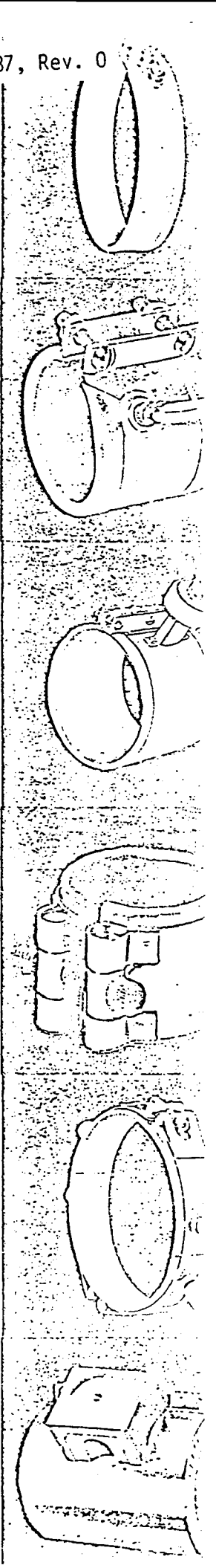
PLASTICS

Over a half century

INDUSTRIAL HEATER CO., INC.

HEATING ELEMENTS





MICA INSULATED BAND HEATERS

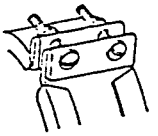
DESIGN VARIATIONS

CUSTOM CONSTRUCTION

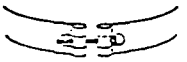
Over 70,000 specifications in our files are the result of manufacturing custom heaters for various applications over the last 55 years. Custom heaters are manufactured to drawings by our experienced versatile personnel. Our heaters satisfy the requirements of machinery manufacturers, research and development engineers and industrial processors throughout the world. Our manufacturing capabilities allow us to construct heaters to suit your application. Our application engineers stand ready to assist you in heater design and will construct heaters the way you want them within our manufacturing capabilities. Stock heater bands may be supplied to maintain production while a custom heater is manufactured to specification. Custom heaters may be constructed to sample as well as drawings. Special handling of orders for custom heaters will minimize machinery down-time in emergency situations.

Custom Heaters may be ordered with these variations

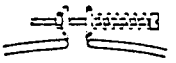
LOCKUP



Flange lockup



Strap lockup
Trunion lockup



Flange lockup with compression springs

On the following pages are illustrated various heater bands with variations in the type of lockup. IHCO "Standard" construction is a reverse double layer flange lockup. Customer preference or particular application may dictate other types of lockup. We offer the following for your selection with custom band heaters:

1 — Flange lockup
2 — Strap lockup
3 — Key lockup
4 — No lockup (mounting holes provided to specification)
5 — Trunion lockup
6 — Compression Springs for firm lockup may be specified. They are included with all IHCO bands 12" ID and larger to insure firm lockup unless specified otherwise by the customer.

TERMINALS AND TERMINAL PROTECTION DEVICES

Screw terminals (type A)

Lead wires (type C)

Conductor Cable and Sleeving Terminals

Shown on the following pages are heater bands with screw terminals, lead wires, twist lock plugs, etc. Most any heater band may be constructed to specification with the following choices:

Screw Terminals	Type A
Button Terminals	
Lead Wires (any length)	Type C

Leads in Greenfield sleeving. Leads in flexible armor

Leads in silicon rubber (or glass wall) sleeving

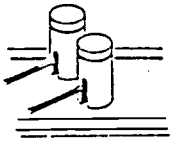
Leads in Teflon sleeving

Twist Lock Plug
Leads in Greenfield Sleeving
Leads in Silicon Rubber Sleeving
Leads in Glass Wall Sleeving
Leads in Teflon Sleeving
Leads in Flexible Armor
Pin Contacts, Foreign & Domestic Type B

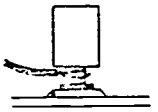
TERMINAL PROTECTION DEVICES
OSHA requirement calls for some terminal protection for the safety of workers. The following are available:

Voltraps Voltraps can be adapted to any screw terminal no matter what the thread size of the screw terminal. Tunnel extension covers heater cable lug or exposed wire. See sketch pg. 18.

Two-Piece Terminal Cap is internally threaded to secure top half to heater terminal. As terminal height is important for these caps, they should be specified with new bands only. 8/32 — 10/32 sizes.



Two piece terminal cap

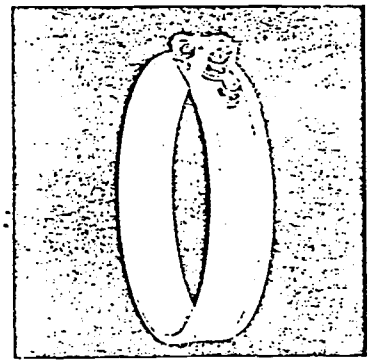


One piece terminal cap

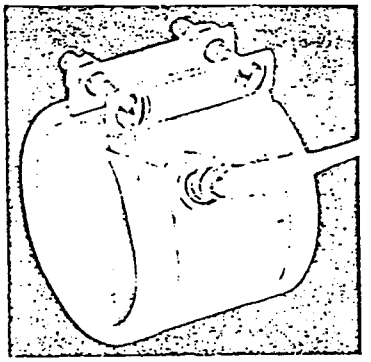
One-Piece Terminal Cap gives adequate protection. Stock size 6/32, 8/32 and 10/32 screw terminals.

Metal Terminal Boxes must be custom constructed to most heater bands and must be incorporated into the band when constructed. As a general rule, metal terminal boxes should not be selected for heater bands less than 3½" in diameter and less than 1½" wide. IHCO terminal boxes are shaped to curvature of the band to minimize possibility of contamination. Bx connector may be provided at customer option. Terminal boxes are mounted on the band heater with internal screws and may be removed for wiring hookup.

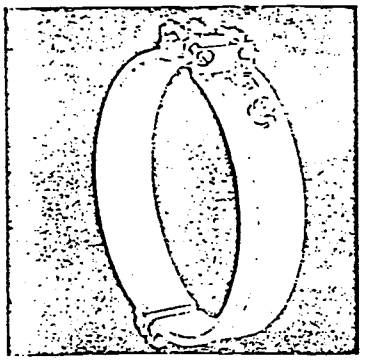
Cylindrical Band Variations illustrated on the following pages are some of the designs we presently manufacture.



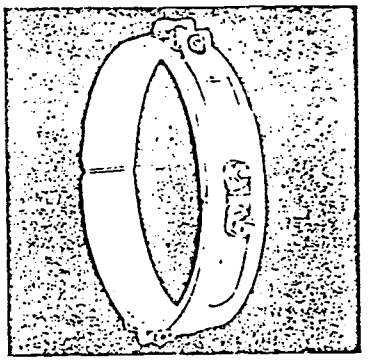
No 1 Heater Band with Screw Terminals



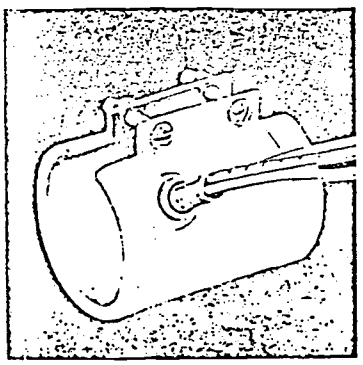
No. 2 Heater Band with Flexible Leads



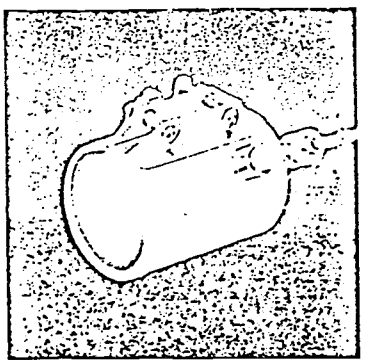
No. 3 Flange Lockup



No. 4 Strap Lockup



No. 5 Dual Voltage



No. 6 Screw-in Thermowell

STANDARD CONSTRUCTION

Review specifications and technical data on pages 2, 3. Review stock list pages 17, 18, 19 and determine if stock heaters or combinations of heaters will suit your requirements.

CUSTOM CONSTRUCTION

Two piece heater bands with flange lockup are preferred by most processors as they are economical and provide firm contact with the cylinder with two lockup points 180 degrees apart. Two piece heaters may be installed without removing other bands or machinery parts in most applications.

Strap lockup may be specified by those who prefer strap lockup. Many flange lockup two piece heaters are carried in stock. Strap lockup two piece heater shown at left should not be confused with our special sealed band (SB) heater illustrated on page 10.

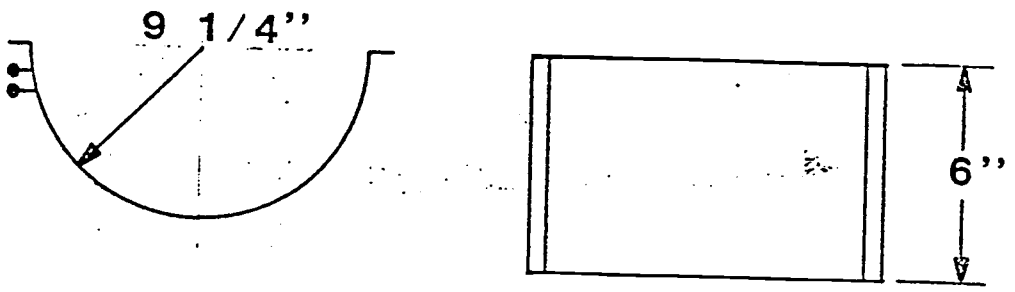
Dual voltage heaters consist of two circuits. May be used in 120/240 or 240/480 volt applications. Heater constructed with two circuits equally distributed which may be wired in series for operation. Dual voltage may be specified with screw terminals or leads.

Thermowell built into band for thermocouple. 1/8" pipe thread standard for most thermocouples. Illus. shown 2" ID x 3" wide.

INDUSTRIAL HEATER CO. INC.

CUSTOM MADE FLANGE LOCKUP BAND HEATERS

HALF SECTION



WATTS: 3000W

WATT DENSITY: 17.2 W/IN 2

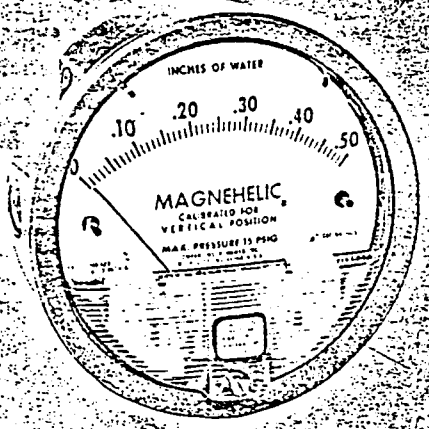
APPENDIX D-11

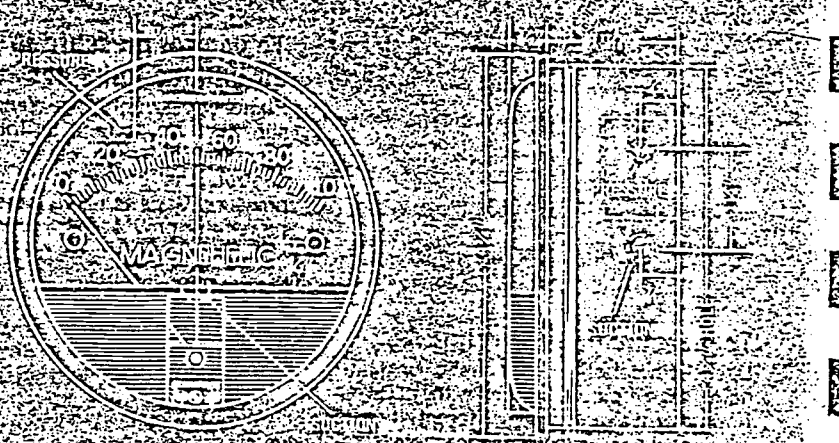
PRESSURE SENSOR SPECIFICATIONS

Dwyer

SERIES 2000 Magnehelic Differential Pressure Gages

Indicate low air or gas pressures—positive, negative or differential. Accurate within 2%. 61 Ranges.

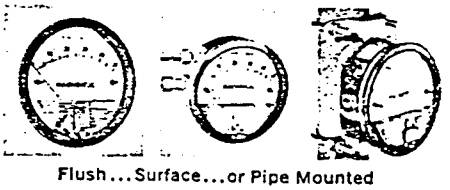




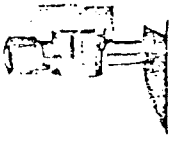
Dimensions: Standard Series 2000 Magnehelic Pressure Gages (Slightly different on medium and high pressure models)

Select the Dwyer Magnehelic® gage for high accuracy — guaranteed within 2% of full scale — and for the wide choice of 61 ranges available to suit your needs precisely. Using Dwyer's simple, frictionless Magnehelic® movement, it quickly indicates low air or non-corrosive gas pressures — either positive, negative (vacuum) or differential. The design resists shock, vibration and over-pressures. No manometer fluid to evaporate, freeze or cause toxic or leveling problems. It's inexpensive, too.

Widely used to measure fan and blower pressures, filter resistance, air velocity, furnace draft, pressure drop across orifice plates, liquid levels with bubbler systems and pressures in fluid amplifier or fluidic systems. It also checks gas-air ratio controls and automatic valves, and monitors blood and respiratory pressures in medical care equipment.


Flush...Surface...or Pipe Mounted

Mounting. A single case size is used for most ranges of Magnehelic gages. They can be flush or surface mounted with standard hardware supplied. With the optional A-610 Pipe Mounting Kit they may be conveniently installed on horizontal or vertical 1¼"-2" pipe. Although calibrated for vertical position, ranges above 1 inch may be used at any angle by simply re-zeroing. These characteristics make Magnehelic gages ideal for both stationary and portable applications. A 4½" hole is required for flush panel mounting. Complete mounting and connection fittings plus instructions are furnished with each instrument.



Vent valves

In applications where pressure is continuous and the Magnehelic gage is connected by metal or plastic tubing which cannot be easily removed, we suggest using Dwyer A-313 vent valves to connect gage. Pressure can then be removed to check or re-zero the gage.

HIGH AND MEDIUM PRESSURE MODELS

Installation is similar to standard gages except that a 4¹³⁄₁₆" hole is needed for flush mounting. The medium pressure construction is rated for internal pressures up to 35 psig and the high pressure up to 80 psig. Available in all ranges. Because of larger case, will not fit in portable case. Weight 1 lb., 10 oz. (Installation of the A-321 safety relief valve on standard Magnehelic gages often provides adequate protection against infrequent overpressure; see Bulletin S-101).

PHYSICAL DATA

Ambient temperature range: 20° to 140°F.*

Rated total pressure: 15 psig.†

Connections: ⅛" NPT high and low pressure taps, duplicated — one pair side and one pair on back.

Housing: Die cast aluminum. Case and aluminum parts Iridite-dipped to withstand 168 hour salt spray test. Exterior finish is baked dark gray hammerloid.

Standard ranges: See facing page.

Accuracy: Plus or minus 2% of full scale (3% on –0 and 4% on –00 ranges), throughout range at 70°F.

Standard accessories: Two ⅛" NPT plugs for duplicate pressure taps, two ⅛" pipe thread to rubber tubing adapters, back mounting spud with washers and jam nut, three flush mounting adapters with screws. (Mounting ring and snap ring retainer substituted for 3 adapters in HP gage accessories).

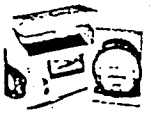
Weight: 1 lb. 2 oz.

*Low temperature models available as special option.
†For applications with high cycle rate within gage total pressure rating, next higher rating is recommended. See Medium and High pressure options at lower left.

OPTIONS AND ACCESSORIES

Transparent overlays
Furnished in red and green to highlight and emphasize critical pressures.

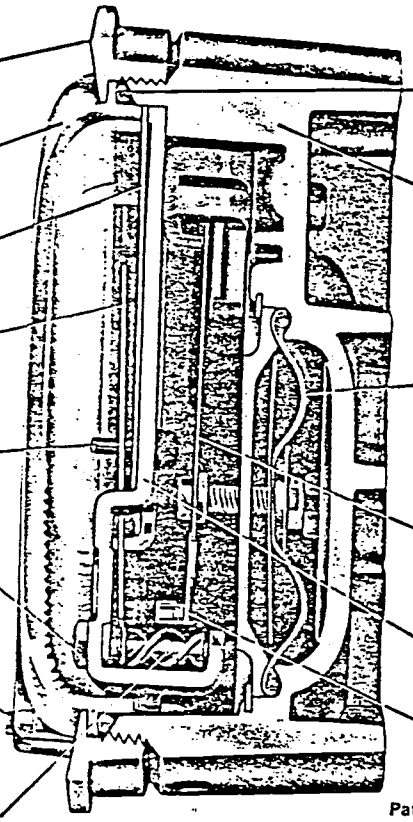
Adjustable signal flag
Integral with plastic gage cover; has external reset screw. Available for all ranges (not high pressure). Can be ordered with gage or separately.



Portable units
Combine carrying case with any Magnehelic gage of standard range (not high pressure). Includes 9 ft. of ¼" I.D. rubber tubing, stand-hang bracket, and terminal tube with holder.

Air filter gage accessory package
Adapts any standard Magnehelic for use as an air filter gage. Includes aluminum surface-mounting bracket with screws, two 5 ft. lengths of ¼" aluminum tubing, two static pressure tips and two molded plastic vent valves, integral compression fittings on both tips and valves.

Quality design and construction features



Bezel provides flange for flush mounting in panel.

Clear plastic face is highly resistant to breakage. Provides undistorted viewing of pointer and scale.

Precision litho-printed scale is accurate and easy to read.

Red tipped pointer of heat treated aluminum tubing is easy to see. It is rigidly mounted on helix shaft.

Pointer stops of molded rubber prevent pointer over-travel without damage.

Sapphire bearings are shock-resistant mounted; provide virtually friction-free motion for helix. Motion damped with high viscosity silicone fluid.

Zero adjustment screw is conveniently located in plastic cover, accessible without removing cover. "0" ring seal provides pressure tightness.

"0" ring seal for cover assures pressure integrity of case.

Die cast aluminum case is precision made. Iridite-dipped to withstand 168 hour salt spray test. Exterior finished in baked dark gray hammerloid. One case size used for all standard pressure ranges, and for both surface and flush mounting.

Silicone rubber diaphragm with integrally molded "0" ring is supported by front and rear plates. It is locked and sealed in position with a sealing plate and retaining ring. Diaphragm motion is restricted to prevent damage due to overpressures.

Calibrated range spring is a flat leaf of Swedish spring steel in temperature compensated design. Small amplitude of motion assures consistency and long life. It reacts to pressure on diaphragm. Live length adjustable for calibration.

"Wishbone" assembly provides mounting for helix, helix bearings and pointer shaft.

Samarium cobalt magnet mounted at end of range spring rotates helix without mechanical linkages.

Patent No. 3,091,123

Helix is precision milled from an alloy of high magnetic permeability, deburred and annealed in a hydrogen atmosphere for best magnetic qualities. Mounted in jeweled bearings, it turns freely to align with magnetic field of magnet to transmit pressure indication to pointer.

SERIES 2000 MAGNEHELIC® — MODELS AND RANGES

The models below will fulfill most requirements. Page 5 also shows examples of special models built for OEM customers. For special scales furnished in ounces per square inch, inches of mercury, metric units, etc., contact the factory.

Model Number	Range, Inches of Water	Minor Div.
2000-00	0- .25	.005
2000-0	0- .50	.01
2001	0-1.0	.02
2002	0-2.0	.05
2003	0-3.0	.10
2004	0-4.0	.10
2005	0-5.0	.10
2006	0-6.0	.20
2008	0-8.0	.20
2010	0-10	.20
2015	0-15	.50
2020	0-20	.50
2025	0-25	.50
2030	0-30	1.0
2040	0-40	1.0
2050	0-50	1.0
2060	0-60	2.0
2080	0-80	2.0
2100	0-100	2.0
	0-150	5.0

Model Number	Range, Metric Scales CM of Water	Minor Div. CM
2000-1CM	0-1	.02
2000-2CM	0-2	.05
2000-5CM	0-5	.10
2000-8CM	0-8	.20
2000-10CM	0-10	.20
2000-15CM	0-15	.50
2000-20CM	0-20	.50
2000-25CM	0-25	.50
2000-30CM	0-30	1.0
2000-40CM	0-40	1.0
2000-50CM	0-50	1.0
2000-80CM	0-80	2.0
2000-100CM	0-100	2.0
2000-150CM	0-150	5.0
2000-200CM	0-200	5.0
2000-250CM	0-250	5.0
2000-300CM	0-300	10.0

Model Number	Range, Metric Scales MM of Water	Minor Div. MM
2000-10MM	0-10	.50
2000-15MM	0-15	.50
2000-20MM	0-20	.50
2000-25MM	0-25	.50
2000-30MM	0-30	1.0
2000-40MM	0-40	1.0
2000-50MM	0-50	1.0
2000-80MM	0-80	2.0
2000-100MM	0-100	2.0
2000-150MM	0-150	5.0
2000-200MM	0-200	5.0
2000-250MM	0-250	5.0
2000-300MM	0-300	10.0

Special Purpose Ranges

Scale No. 2401	Scale No. 2402
Square Root	Blank Scale
Specify Range	Specify Range

Model Number	Range, Zero Center Inches of Water	Minor Div.
2301	.5-0-.5	.02
2302	1-0-1	.05
2304	2-0-2	.10
2310	5-0-5	.20
2320	10-0-10	.50
2330	15-0-15	1.0

Model Number	Range, PSIG	Minor Div. PSIG
2201	0-1	.02
2202	0-2	.05
2203	0-3	.10
2204	0-4	.10
2205	0-5	.10
2210*	0-10	.20
2215*	0-15	.50
2220*	0-20	.50

*These ranges equipped as Medium Pressure Models (see Options).

Model Number	Range, Zero Center Metric CM of Water	Minor Div. CM
2300-4CM	2-0-2	.10
2300-10CM	5-0-5	.20
2300-20CM	10-0-10	.50
2300-30CM	15-0-15	1.0

Model Number	Range, Zero Center Metric MM of Water	Minor Div. MM
2300-20MM	10-0-10	.50
2300-30MM	15-0-15	1.0

Dual Scale Air Velocity Units*

Model Number	Range, Inches of Water	Range, Air Velocity F.P.M.
2000-00AV	0- .25	300- 2000
2000-0AV	0- .50	500- 2800
2001AV	0-1.0	500- 4000
2002AV	0-2.0	1000- 5600
2010AV	0-10	2000-12500

*For use with pitot tube.

Suggested Specifications.

"Differential pressure gage for measuring (state purpose) shall be installed. Gage shall be the diaphragm-actuated dial type 4¾" O.D., with white dial, black figures and graduations and pointer zero adjustment. Gage shall be Dwyer Instruments, Inc., Magnehelic®, Catalog No. _____ reading to _____" water column, in _____" divisions.

APPENDIX D-12

CONTROL PANEL SPECIFICATIONS

BULLETIN A-12

NEMA TYPE 12 ENCLOSURES

STANDARD SIZES

SINGLE DOOR WALL-MOUNTED

Enclosure Catalog Number	Enclosure Size A x B x C	*Panel Catalog Number	Panel Size	Enclosure Catalog Number	Enclosure Size A x B x C	*Panel Catalog Number	Panel Size
●A-122406LP	12 x 24 x 6	A-12P24	9 x 21	A-603608LP	60 x 36 x 8	A-60P36	57 x 33
●A-161206LP	16 x 12 x 6	A-16P12	13 x 9	●A-161210LP	16 x 12 x 10	A-16P12	13 x 9
●A-161606LP	16 x 16 x 6	A-16P16	13 x 13	●A-201610LP	20 x 16 x 10	A-20P16	17 x 13
●A-162006LP	16 x 20 x 6	A-20P16	17 x 13	●A-202010LP	20 x 20 x 10	A-20P20	17 x 17
●A-201206LP	20 x 12 x 6	A-20P12	17 x 9	●A-241210LP	24 x 12 x 10	A-12P24	9 x 21
●A-201606LP	20 x 16 x 6	A-20P16	17 x 13	●A-242010LP	24 x 20 x 10	A-24P20	21 x 17
●A-202006LP	20 x 20 x 6	A-20P20	17 x 17	●A-242410LP	24 x 24 x 10	A-24P24	21 x 21
●A-202406LP	20 x 24 x 6	A-24P20	21 x 17	●A-302010LP	30 x 20 x 10	A-30P20	27 x 17
●A-241206LP	24 x 12 x 6	A-12P24	9 x 21	●A-302410LP	30 x 24 x 10	A-30P24	27 x 21
●A-241606LP	24 x 16 x 6	A-24P16	21 x 13	●A-362410LP	36 x 24 x 10	A-36P24	33 x 21
●A-242006LP	24 x 20 x 6	A-24P20	21 x 17	A-363010LP	36 x 30 x 10	A-36P30	33 x 27
●A-242406LP	24 x 24 x 6	A-24P24	21 x 21	A-423010LP	42 x 30 x 10	A-42P30	39 x 27
●A-301606LP	30 x 16 x 6	A-30P16	27 x 13	A-423610LP	42 x 36 x 10	A-42P36	39 x 33
●A-302006LP	30 x 20 x 6	A-30P20	27 x 17	A-483010LP	48 x 30 x 10	A-48P30	45 x 27
●A-302406LP	30 x 24 x 6	A-30P24	27 x 21	A-483610LP	48 x 36 x 10	A-48P36	45 x 33
●A-362406LP	36 x 24 x 6	A-36P24	33 x 21	A-603610LP	60 x 36 x 10	A-60P36	57 x 33
A-363006LP	36 x 30 x 6	A-36P30	33 x 27	●A-201612LP	20 x 16 x 12	A-20P16	17 x 13
●A-122408LP	12 x 24 x 8	A-12P24	9 x 21	●A-242012LP	24 x 20 x 12	A-24P20	21 x 17
●A-161208LP	16 x 12 x 8	A-16P12	13 x 9	●A-242412LP	24 x 24 x 12	A-24P24	21 x 21
●A-161608LP	16 x 16 x 8	A-16P16	13 x 13	●A-302412LP	30 x 24 x 12	A-30P24	27 x 21
●A-162008LP	16 x 20 x 8	A-20P16	17 x 13	A-303012LP	30 x 30 x 12	A-30P30	27 x 27
●A-201208LP	20 x 12 x 8	A-20P12	17 x 9	●A-362412LP	36 x 24 x 12	A-36P24	33 x 21
●A-201608LP	20 x 16 x 8	A-20P16	17 x 13	A-363012LP	36 x 30 x 12	A-36P30	33 x 27
●A-202008LP	20 x 20 x 8	A-20P20	17 x 17	A-363612LP	36 x 36 x 12	A-36P36	33 x 33
●A-202408LP	20 x 24 x 8	A-24P20	21 x 17	A-423012LP	42 x 30 x 12	A-42P30	39 x 27
●A-241208LP	24 x 12 x 8	A-12P24	9 x 21	A-423612LP	42 x 36 x 12	A-42P36	39 x 33
●A-241608LP	24 x 16 x 8	A-24P16	21 x 13	A-483612LP	48 x 36 x 12	A-48P36	45 x 33
●A-242008LP	24 x 20 x 8	A-24P20	21 x 17	A-603612LP	60 x 36 x 12	A-60P36	57 x 33
●A-242408LP	24 x 24 x 8	A-24P24	21 x 21	A-723012LP	72 x 30 x 12	A-72P30	69 x 27
●A-243008LP	24 x 30 x 8	A-30P24	27 x 21	●A-242016LP	24 x 20 x 16	A-24P20	21 x 17
●A-302008LP	30 x 20 x 8	A-30P20	27 x 17	●A-242416LP	24 x 24 x 16	A-24P24	21 x 21
●A-302408LP	30 x 24 x 8	A-30P24	27 x 21	●A-302416LP	30 x 24 x 16	A-30P24	27 x 21
A-303008LP	30 x 30 x 8	A-30P30	27 x 27	A-363016LP	36 x 30 x 16	A-36P30	33 x 27
A-303608LP	30 x 36 x 8	A-36P30	33 x 27	A-423616LP	42 x 36 x 16	A-42P36	39 x 33
●A-362408LP	36 x 24 x 8	A-36P24	33 x 21	A-483616LP	48 x 36 x 16	A-48P36	45 x 33
A-363008LP	36 x 30 x 8	A-36P30	33 x 27	A-603616LP	60 x 36 x 16	A-60P36	57 x 33
A-363608LP	36 x 36 x 8	A-36P36	33 x 33	A-723016LP	72 x 30 x 16	A-72P30	69 x 27
●A-422408LP	42 x 24 x 8	A-42P24	39 x 21	●A-302420LP	30 x 24 x 20	A-30P24	27 x 21
A-423008LP	42 x 30 x 8	A-42P30	39 x 27	A-363020LP	36 x 30 x 20	A-36P30	33 x 27
A-423608LP	42 x 36 x 8	A-42P36	39 x 33	A-483620LP	48 x 36 x 20	A-48P36	45 x 33
●A-482408LP	48 x 24 x 8	A-48P24	45 x 21	A-603620LP	60 x 36 x 20	A-60P36	57 x 33
A-483008LP	48 x 30 x 8	A-48P30	45 x 27	A-723020LP	72 x 30 x 20	A-72P30	69 x 27
A-483608LP	48 x 36 x 8	A-48P36	45 x 33	A-723024LP	72 x 30 x 24	A-72P30	69 x 27

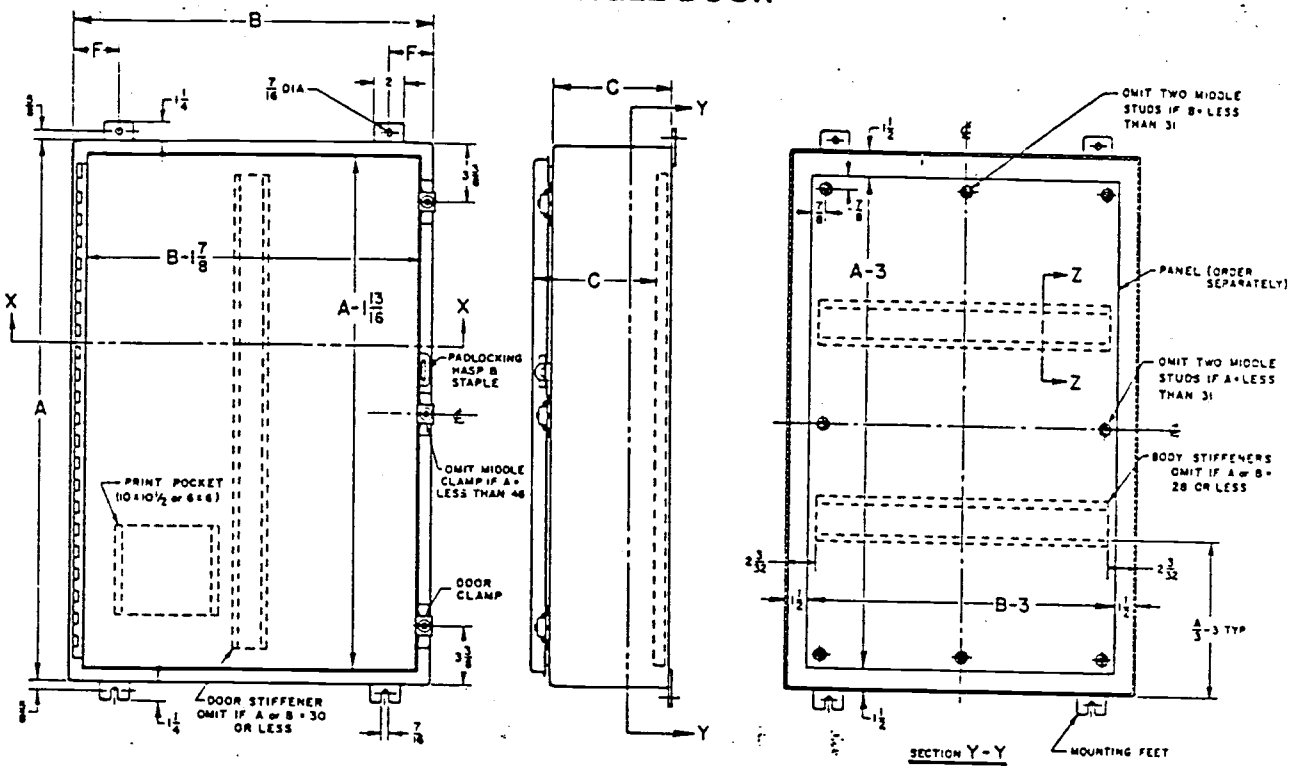
*Panels must be ordered separately. ● U.L. LISTED

STANDARD SIZES

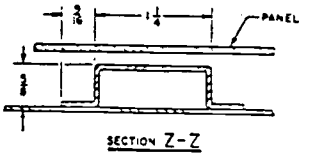
TWO DOOR FLOOR-MOUNTED

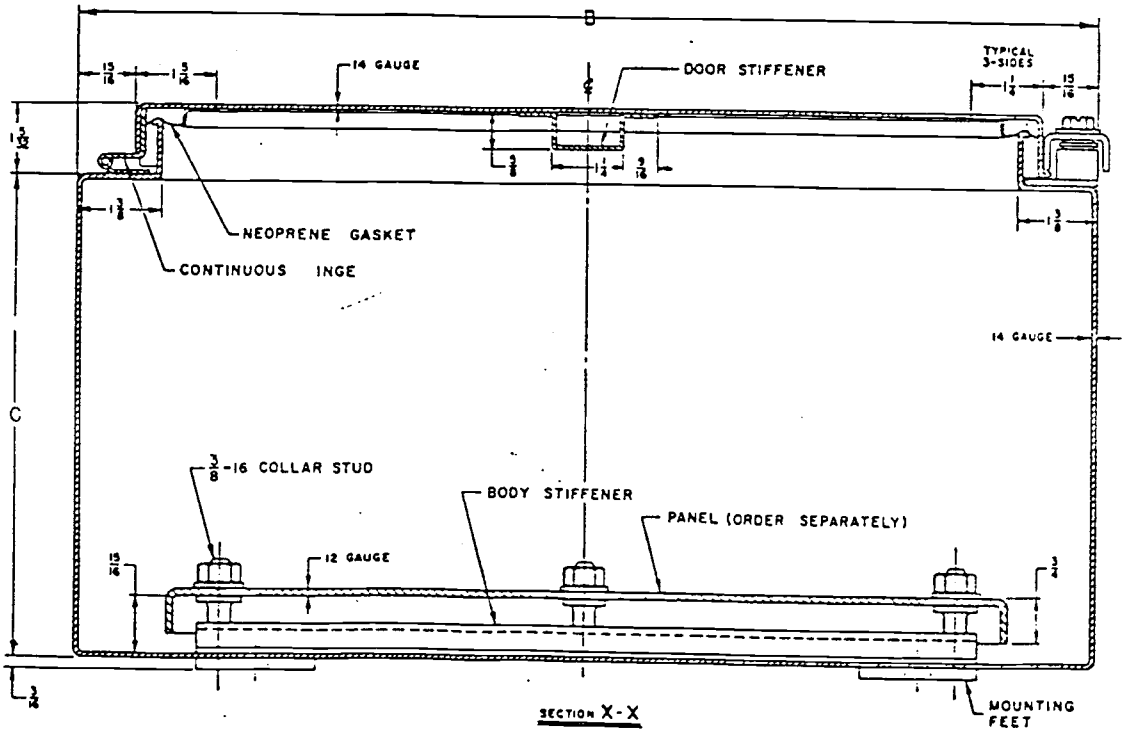
Enclosure Catalog Number	Enclosure Size A x B x C	*Panel Catalog Number	Panel Size	Enclosure Catalog Number	Enclosure Size A x B x C	*Panel Catalog Number	Panel Size
A-544208LP	54 x 42 x 8	A-54P42	50 x 38	A-606016LP	60 9/16 x 60 9/16 x 16 9/16	A-60P60	56 x 56
A-604808LP	60 9/16 x 48 9/16 x 8 9/16	A-60P48	56 x 44	A-726016LP	72 9/16 x 60 9/16 x 16 9/16	A-72P60	68 x 56
A-604810LP	60 9/16 x 48 9/16 x 10 9/16	A-60P48	56 x 44	A-727216LP	72 9/16 x 72 9/16 x 16 9/16	A-72P72	68 x 68
A-606010LP	60 9/16 x 60 9/16 x 10 9/16	A-60P60	56 x 56	A-604820LP	60 9/16 x 48 9/16 x 20 9/16	A-60P48	56 x 44
A-726010LP	72 9/16 x 60 9/16 x 10 9/16	A-72P60	68 x 56	A-726020LP	72 9/16 x 60 9/16 x 20 9/16	A-72P60	68 x 56
A-727210LP	72 9/16 x 72 9/16 x 10 9/16	A-72P72	68 x 68	A-727220LP	72 9/16 x 72 9/16 x 20 9/16	A-72P72	68 x 68
A-604812LP	60 9/16 x 48 9/16 x 12 9/16	A-60P48	56 x 44	A-604824LP	60 9/16 x 48 9/16 x 24 9/16	A-60P48	56 x 44
A-606012LP	60 9/16 x 60 9/16 x 12 9/16	A-60P60	56 x 56	A-606024LP	60 9/16 x 60 9/16 x 24 9/16	A-60P60	56 x 56
A-726012LP	72 9/16 x 60 9/16 x 12 9/16	A-72P60	68 x 56	A-726024LP	72 9/16 x 60 9/16 x 24 9/16	A-72P60	68 x 56
A-727212LP	72 9/16 x 72 9/16 x 12 9/16	A-72P72	68 x 68	A-727224LP	72 9/16 x 72 9/16 x 24 9/16	A-72P72	68 x 68
A-604816LP	60 9/16 x 48 9/16 x 16 9/16	A-60P48					

SINGLE DOOR



NOTE:
1. F = 3 when B = 16 or more; F = 1¼ when B is less than 16.
2. Large print pocket furnished if A = 30 or more and B = 20 or more.
3. Panels have flanges along sides which are more than 17 inches long.





HEAVY-DUTY, OILTIGHT PUSH BUTTONS

600 Volts Max. Ac/Dc 10 Amps Continuous

D-5, D-5H, D-5K

APPLICATION

Especially adapted to machine-tool service or any application where oil or coolant is present. The convenient one-hole mounting and small size also makes this line suitable for general purpose use in equipment of all kinds where panel mounting is possible. This line is ideal for applications where space is at a premium and long life is essential.

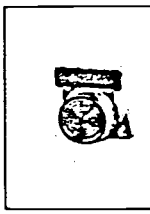
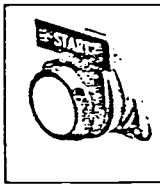
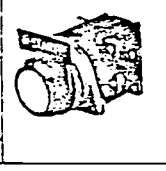
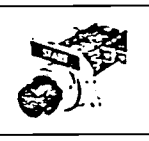
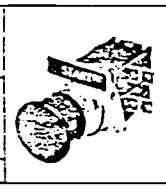
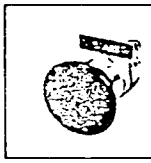
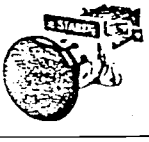
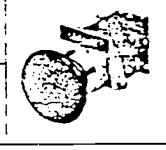
CONTACT RATINGS

(600 Volts Max.) (Do not apply to UW234 and U300 forms)

Volts	Carry Continuous Amps	Make Momentary Amps	Interrupting Capacity—Amps	
			Ac Circuits	Dc Inductive Circuits
110-125	10	60	6.0	2.2
220-250	10	30	3.0	1.1
440-480	10	15	1.5	...
550-600	10	12	1.2	0.4

PRICING INFORMATION

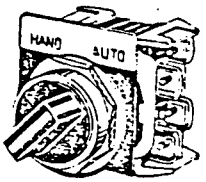
Push-button Units (Momentary contact)

Operator Alone				Operator with Single Block (1NO-1NC)			Operator with Double Block (2NO-2NC)		
	Color of Button Ring and/or Button (Standard Button Silver Only)	Catalog Number	① List Price, GO-10G	(Front) (Back) SPDT	Catalog Number	① List Price, GO-10G	(Front) (Back) DPDT	Catalog Number	① List Price, GO-10G
STANDARD WITH COLORED BUTTON									
	Black	CR2940WA200B	$10.80		CR2940WA202B	$22.80		CR2940WA203B	$34.80
	Red	WA200C	10.80		WA202C	22.80		WA203C	34.80
	Yellow	WA200D	10.80		WA202D	22.80		WA203D	34.80
	Green	CR2940WA200E	10.80		CR2940WA202E	22.80		CR2940WA203E	34.80
	White	WA200F	10.80		WA202F	22.80		WA203F	34.80
	Blue	WA200AR	10.80		WA202AR	22.80		WA203AR	34.80
	Orange	WA200BY	10.80		WA202BY	22.80		WA203BY	34.80
	None	CR2940WA200A②	10.60		.....	...		.....	...
	All	CR2940WA200YA	10.80		.....	...		.....	...
STANDARD WITH COLORED RING									
	Black	CR2940UA200B③	$10.80		CR2940UA202B	$22.80		CR2940UA203B	$34.80
	Red	UA200C③	10.80		UA202C	22.80		UA203C	34.80
	Yellow	UA200D	10.80		UA202D	22.80		UA203D	34.80
	Green	CR2940UA200E	10.80		CR2940UA202E	22.80		CR2940UA203E	34.80
	White	UA200F	10.80		UA202F	22.80		UA203F	34.80
	Blue	UA200AR	10.80		UA202AR	22.80		UA203AR	34.80
	Orange	UA200BY	10.80		UA202BY	22.80		UA203BY	34.80
	None④	CR2940UA200A	10.00		.....	...		.....	...
EXTRA LONG BUTTON (5/8-inch Length)									
	Black	CR2940UJ200B	$10.80		CR2940UJ202B	$22.80		CR2940UJ203B	$34.80
	Red	UJ200C	10.80		UJ202C	22.80		UJ203C	34.80
MUSHROOM HEAD (1 9/16-inch Diameter)									
	Black	CR2940UK200B	$22.80		CR2940UK202B	$34.80		CR2940UK203B	$46.80
	Red	UK200C	22.80		UK202C	34.80		UK203C	46.80
	Yellow	UK200D	22.80		UK202D	34.80		UK203D	46.80
	Green	CR2940UK200M	22.80		CR2940UK202M	34.80		CR2940UK203M	46.80
	White	UK200AK	22.80		UK202AK	34.80		UK203AK	46.80
	Blue	UK200AC	22.80		UK202AC	34.80		UK203AC	46.80
	Orange	UK200AB	22.80		UK202AB	34.80		UK203AB	46.80
	None	CR2940UK200BA③	18.80		.....	...		.....	...
MUSHROOM HEAD (2 1/4-inch Diameter)									
	Black	CR2940UK200F	$22.80		CR2940UK202F	$34.80		CR2940UK203F	$46.80
	Red	UK200H	22.80		UK202H	34.80		UK203H	46.80
	Yellow	UK200J	22.80		UK202J	34.80		UK203J	46.80
	Green	CR2940UK200G	22.80		CR2940UK202G	34.80		CR2940UK203G	46.80
	White	UK200L	22.80		UK202L	34.80		UK203L	46.80
	Blue	UK200K	22.80		UK202K	34.80		UK203K	46.80
	Orange	UK200AL	22.80		UK202AL	34.80		UK203AL	46.80

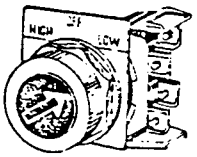
① Price does not include nameplate. Must be ordered as a separate item. See page 188 for nameplate ordering and pricing information.
②③ Refer to table at top of page 179 for color caps and/or mushroom head buttons.
④ Units are individually boxed and "Poly-Packed" 20 per carton as standard.
⑤ Order 13/32-inch ring separately from page 186 (Accessories and Components).

REFERENCE:
Descriptive bulletin GEA-9473

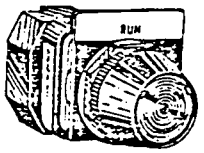
Nameplate Selection..... pages 188, 189
Dimensions and Drilling Plan ..... page 189



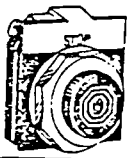
Bulletin 800T
Selector Switch
Cat. No. H2B



Coin Slot
Selector Switch Unit
Type J6A



Bulletin 800T
Pilot Light
Cat. No. P26R



B6A

BULLETIN 800T SELECTOR SWITCH UNITS

Prices Include – Prices for complete units and operators only include a standard nameplate.

Contact Arrangement	Type of Operator	Complete Unit No.	Complete Unit List Each	Operator Only No.	Operator Only List Each	Contact Block Only No.	Contact Block Only List Each
1 NO-NC Contact	2 POSITION Standard	H2A	$28.00	H2	$16.00	XA	$12.00
	Coin Slot	H6A	36.00	H6	24.00	XA	12.00
	Cylinder Lock						
	Lock in Left Position	H31A	52.00	H31	40.00	XA	12.00
	Lock in Right Position	H32A	52.00	H32	40.00	XA	12.00
	Lock in All Positions	H33A	52.00	H33	40.00	XA	12.00
2 NO-NC Contacts	2 POSITION Standard	H2B	40.00	H2	16.00	XB	24.00
	Coin Slot	H6B	48.00	H6	24.00	XB	24.00
	Cylinder Lock						
	Lock in Left Position	H31B	64.00	H31	40.00	XB	24.00
	Lock in Right Position	H32B	64.00	H32	40.00	XB	24.00
	Lock in All Positions	H33B	64.00	H33	40.00	XB	24.00
1 NO-NC Contact	3 POSITION Standard	J2A	28.00	J2	16.00	XA	12.00
	Coin Slot	J6A	36.00	J6	24.00	XA	12.00
	Cylinder Lock						
	Lock in Left Position	J41A	52.00	J41	40.00	XA	12.00
	Lock in Center Position	J42A	52.00	J42	40.00	XA	12.00
	Lock in Right Position	J43A	52.00	J43	40.00	XA	12.00
	Lock in All Positions	J44A	52.00	J44	40.00	XA	12.00
2 NO-NC Contacts	3 POSITION Standard	J2B	40.00	J2	16.00	XB	24.00
	Coin Slot	J6B	48.00	J6	24.00	XB	24.00
	Cylinder Lock						
	Lock in Left Position	J41B	64.00	J41	40.00	XB	24.00
	Lock in Center Position	J42B	64.00	J42	40.00	XB	24.00
	Lock in Right Position	J43B	64.00	J43	40.00	XB	24.00
	Lock in All Positions	J44B	64.00	J44	40.00	XB	24.00

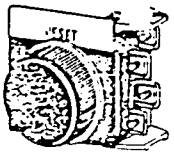
MOMENTARY CONTACT PUSH BUTTON UNITS

Extended Head

Price Of Unit Includes A Standard Nameplate

Color Of Button *	1 NO-1 NC No.	1 NO-1 NC List	2 NO-2 NC No.	2 NO-2 NC List	3 NO-3 NC No.	3 NO-3 NC List	4 NO-4 NC No.	4 NO-4 NC List
Green	800T-B1A	$24.00	800T-B1B	$36.00	800T-B1H	$48.00	800T-B1C	$60.00
Black	B2A		B2B		B2H		B2C	
Red	B6A		B6B		B6H		B6C	

RUBBER BOOT



No.	Color	List Each
800TN5	Black	$4.00
800TN6	Red	4.00
800TN7	Green	4.00

PILOT LIGHT UNITS

Price Include – Prices include bulb, color cap and a standard nameplate. Deduct $1.20 if nameplate is not required.

Volts	Transformer Type 60/50 Hertz No.	Transformer Type 60/50 Hertz List Each	Transformer Type Push-to-Test 60/50 Hertz No.	Transformer Type Push-to-Test 60/50 Hertz List Each	Full Voltage Type Filament Bulb No.	Full Voltage Type Filament Bulb List Each	Full Voltage Type Neon Bulb No.	Full Voltage Type Neon Bulb List Each
120	P16R	$44.00	PT16R	$56.00	Q10R	$36.00	R10A	$36.00
240	P26R	44.00	PT26R	56.00	Q20R	36.00	R20A	36.00
480	P46R	44.00	PT46R	56.00	–	–	–	–
600	P56R	44.00	PT56R	56.00	–	–	–	–

* – Special colors available at no additional charge. Replace the first number of the listed catalog number with the color code number selected from the table to the right.

Color	Orange	Gray	Blue	Brown	Yellow
Code	3	4	7	8	9

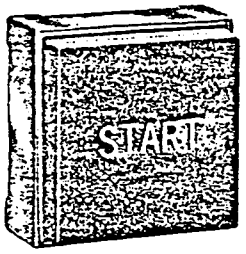
Heavy Duty Oiltight Compact Pushbuttons — Operators Only

WHEN ORDERING SPECIFY

- Catalog Number of Operator
- Catalog Number of Button(s)
- Catalog Number of Contact Block(s)
- Catalog Number of Accessories

MAXIMUM AMPERE RATINGS

Current	A-c Volts				D-c Volts	
	120	240	480	600	125	250
	Amperes				Amperes	
Make & Emerg. Interr. Cap.	60	30	15	12	1.1	0.55
Normal Load Break	6	3	1.5	1.2	1.1	0.55
Continuous Current	10					

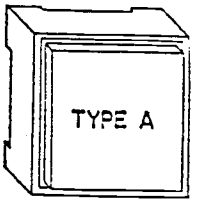


Single Button Operator With Extended Button

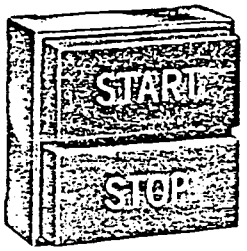
SINGLE BUTTON OPERATOR /WITHOUT BUTTON — NEMA 13

Operation	Special Features	Catalog Number	Price
Momentary	.....	E30 AA	$12.

BUTTON TYPE REQUIRED



ORDER FROM TABLE ON PAGE 194

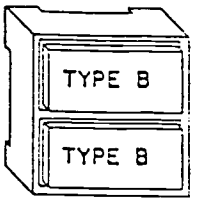


Two Button Operator With Extended Buttons

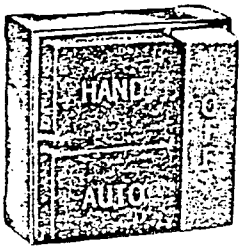
TWO BUTTON OPERATOR /WITHOUT BUTTONS — NEMA 13

Operation		Special Features	Catalog Number	Price
Top Button	Bottom Button			
Momentary	Momentary	.....	E30 AB	$19.20
Momentary	Momentary	With Mechanical Interlock	AC	21.20
Maintained (All Contacts)	Release (All Contacts)	With Mechanical Interlock	AD ❷❸	35.20
Momentary (All Contacts)	Momentary (Bottom Contacts Only)	Top Button Operates Both Top and Bottom Contacts	AE	21.20

BUTTON TYPES REQUIRED



ORDER FROM TABLE ON PAGE 194



Two Button Operator With Long Release Bar

TWO BUTTON OPERATOR WITH LONG ("OFF") RELEASE BAR /WITHOUT BUTTONS — NEMA 13

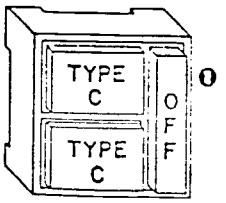
Operation		Special Features	Catalog Number	Price
Top Button	Bottom Button			
Maintained	Maintained	.....	E30 AF	$22.
Maintained	Maintained	With Mechanical Interlock	AG	24.
Maintained	Momentary	With Mechanical Interlock	AH	24.
Maintained (All Contacts)	Momentary (Bottom Contacts Only)	Top Button Operates Both Top and Bottom Contacts	AJ❷	32.
Maintained (All Contacts)	Maintained (Bottom Contacts Only)	Top Button Operates Both Top and Bottom Contacts	AK❷	32.

❶ Operators are supplied as standard with red extended release bar(s) marked "OFF" as shown in sketch. For other colors or markings refer to your Cutler-Hammer Distributor or C-H sales office. For replacement of standard red release bar, order E30KR100 ($2.40).

❷ Limited to two single circuit, one double circuit 600V or two 120V (E30KLA9) contact blocks behind each button.

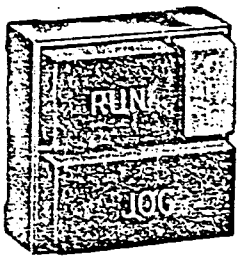
❸ Buttons are interlocked so that one of the two is maintained at all times. Depressing the other button releases the maintained button and maintains the depressed button.

BUTTON TYPES REQUIRED

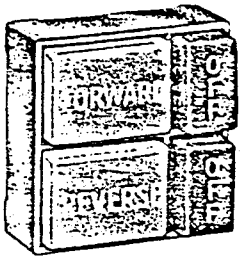


ORDER FROM TABLE ON PAGE 194

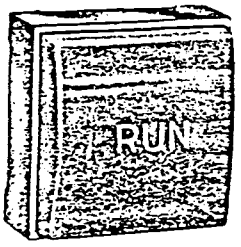
Heavy Duty Oiltight Compact Pushbuttons and Indicating Lights — Operators Only



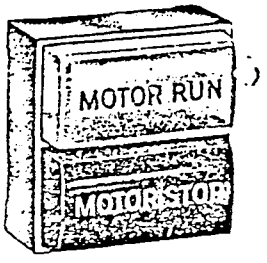
Two Button Operator With Release Bar for Top Button



Two Button Operator W/Individual Release Bars for Each Button



Single Indicating Light Unit

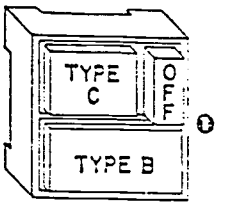


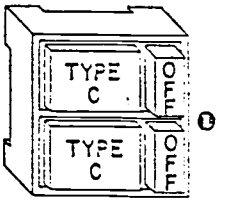
Dual Indicating Light Unit

TWO BUTTON OPERATORS WITH ("OFF") RELEASE BAR(S) /WITHOUT BUTTONS — NEMA 13

Operation		Special Features	Catalog Number	Price
Top Button	Bottom Button			
Maintained	Momentary	Release Bar for Top Button	E30 AL	$24.
Maintained	Maintained	Individual Release Bars for Each Button	AN	28.
Maintained	Maintained	Individual Release Bars for Each Button	AM	32.
With Interlock				

BUTTON TYPES REQUIRED



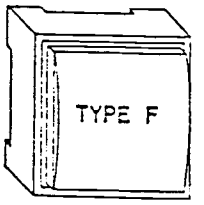


ORDER FROM TABLES ON PAGE 194

SINGLE INDICATING LIGHT UNIT /WITHOUT LENS — NEMA 13

Type of Light Element							
Transformer (60/50 Hertz A-c)				Full Voltage (60/50 Hertz A-c or D-c)			
Volts	Lamp No.	Cat. No.	Price	Volts	Lamp No.	Cat. No.	Price
		E30				E30	
120	#259	BA	$49.60	6	6PSB	BF	$33.60
208		BW	57.60	12	12PSB	BG	33.60
240		BB	57.60	18/24	24PSB	BJ	33.60
380		BC	57.60	28	28PSB	BS	33.60
480		BD	57.60	32	28PSB	BK②	41.60
600		BE	57.60	48	48PSB	BL	33.60
...		...	.....	120	120PSB	BM	33.60

LENS TYPE REQUIRED



ORDER FROM TABLE ON PAGE 195

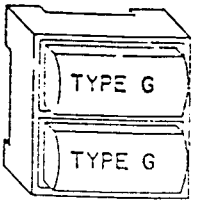
DUAL INDICATING LIGHT UNIT /WITHOUT LENSES — NEMA 13

Type of Light Element							
Transformer (60/50 Hertz A-c)				Full Voltage (60/50 Hertz A-c or D-c)			
Volts	Lamp No.	Cat. No.	Price	Volts	Lamp No.	Cat. No.	Price
		E30				E30	
120	6PSB	CA	$91.20	6	6PSB	CF	$67.20
208		CW	99.20	12	12PSB	CG	67.20
240		CB	99.20	18/24	24PSB	CJ	67.20
380		CC	99.20	28	28PSB	CS	67.20
480		CD	99.20	32	28PSB	CK②	75.20
600		CE	99.20	48	48PSB	CL	67.20
...		...	.....	120	120PSB	CM	67.20

① Operators are supplied as standard with red extended release bar(s) marked "OFF" as shown in sketch. For other colors or markings refer to your Cutler-Hammer Distributor or C-H sales office. For replacement of standard red release bar, order E30KR101 ($2.40).

② 28 Volt Lamp with series resistor.

LENS TYPES REQUIRED



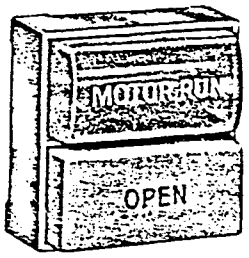
ORDER FROM TABLE ON PAGE 195

Heavy Duty Oiltight Compact Combination Pushbutton and Indicating Light Operators

WHEN ORDERING SPECIFY

- Catalog Number of Operator
- Catalog Number of Button(s) or Lens(es)
- Catalog Number of Contact Block(s)
- Catalog Number of Accessories

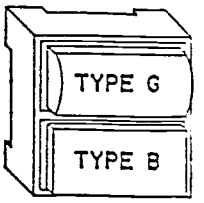
SINGLE BUTTON OPERATOR WITH INDICATING LIGHT / WITHOUT BUTTON OR LENS — NEMA 13



Single Button Operator With Indicating Light

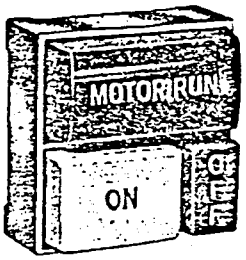
Operation (Bottom Button)	Type of Light Element: Transformer (60/50 Hertz A-c) Volts	Lamp No.	Cat. No.	Price	Full Voltage (60/50 Hertz A-c or D-c) Volts	Lamp No.	Cat. No.	Price
Momentary			E30				E30	
	120	6PSB	DA	$59.20	6	6PSB	DX1	$43.20
	208		DN	67.20	12	12PSB	DX2	43.20
	240		DB	67.20	18/24	24PSB	DX3	43.20
	380		DC	67.20	28	28PSB	DX4	43.20
	480		DD	67.20	48	48PSB	DX6	43.20
	600		DE	67.20	120	120PSB	DF	43.20

BUTTON AND LENS TYPES REQUIRED



ORDER FROM TABLES ON PAGES 194 & 195

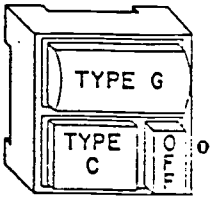
SINGLE BUTTON OPERATOR WITH ("OFF") RELEASE BAR AND INDICATING LIGHT / WITHOUT BUTTON OR LENS — NEMA 13



Single Button Operator With Release Bar and Indicating Light

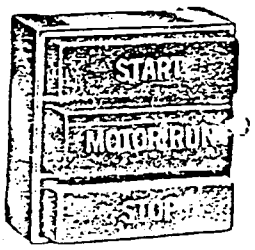
Operation (Bottom Button)	Type of Light Element: Transformer (60/50 Hertz A-c) Volts	Lamp No.	Cat. No.	Price	Full Voltage (60/50 Hertz A-c or D-c) Volts	Lamp No.	Cat. No.	Price
Maintained			E30				E30	
	120	6PSB	DG	$63.20	6	6PSB	DX11	$47.20
	208		DP	71.20	12	12PSB	DX12	47.20
	240		DH	71.20	18/24	24PSB	DX13	47.20
	380		DJ	71.20	28	28PSB	DX14	47.20
	480		DK	71.20	48	48PSB	DX16	47.20
	600		DL	71.20	120	120PSB	DM	47.20

BUTTON AND LENS TYPES REQUIRED



ORDER FROM TABLES ON PAGES 194 & 195

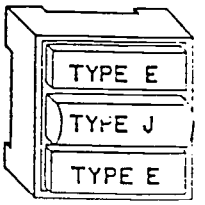
TWO BUTTON OPERATOR WITH INDICATING LIGHT / WITHOUT BUTTONS OR LENS — NEMA 13



Two Button Operator With Indicating Light

Button Operation	Type of Light Element: Transformer (60/50 Hertz A-c) Volts	Lamp No.	Cat. No.	Price	Full Voltage (60/50 Hertz A-c or D-c) Volts	Lamp No.	Cat. No.	Price
Momentary			E30				E30	
	120	6PSB	EA	$68.80	6	6PSB	EX1	$48.80
	208		EN	76.80	12	12PSB	EX2	48.80
	240		EB	76.80	18/24	24PSB	EX3	48.80
	380		EC	76.80	28	28PSB	EX4	48.80
	480		ED	76.80	48	48PSB	EX6	48.80
	600		EE	76.80	120	120PSB	EF	48.80
Momentary With Interlock	120	6PSB	EG	72.80	6	6PSB	EX11	$52.80
	208		EP	80.80	12	12PSB	EX12	52.80
	240		EH	80.80	18/24	24PSB	EX13	52.80
	380		EJ	80.80	28	28PSB	EX14	52.80
	480		EK	80.80	48	48PSB	EX16	52.80
	600		EL	80.80	120	120PSB	EM	52.80

BUTTONS AND LENS TYPES REQUIRED



ORDER FROM TABLES ON PAGES 195 & 196

O These operators are supplied as standard with red extended release bar(s) marked "OFF" as shown in sketch. For other colors or markings refer to your Cutler-Hammer Distributor or C-H sales office. For replacement of standard red release bar, order E30KR101 ($2.40).

DISCOUNT SCHEDULE 2CD DIMENSIONS, Pages 202 and 203 REPLACEMENT LAMPS, Page 256 ACCESSORIES AND CONTACT BLOCKS, Pages 196 and 197

ALLEN-BRADLEY BULLETIN 700 TYPE N CONTROL RELAYS

Convertible Contacts

Open Type

Compact construction greatly reduces relay panel size and simplifies panel layout, wiring and maintenance. All relays have convertible contact cartridges which can be arranged in any NO/NC combination. Relays are manually operated by pressing red bar at the center of nameplate; red bar also gives visual indication of relay operation. Timers are supplied with On-Delay action, easily converted to Off-Delay and have 2 double-break contacts; contact arrangement is 1 NO and 1 NC, convertible to either 2 NO or 2 NC. Timing range 0.2 to 60 secs. Accuracy ±1% of the setting. **Specify Voltages and Frequency.**

No.	No. Of Contacts	List Each
Electrically Held Relays		
700-N200	2	$ 48.00
700-N400	4	64.00
700-N600	6	80.00
700-N800	8	96.00
With Pneumatic Timer		
700-NT200	2	$160.00
700-NT400	4	176.00
Permanent Magnet Latched Relays		
700-NM200	2	$104.00
700-NM400	4	120.00
700-NM600	6	136.00
With Penumatic Timer		
700-NMT200	2	$216.00

Accessories

Mounting Strips – Simplifies panel layout. These indexed strips are easily cut to the required length and bolted, riveted, or spot-welded in place. Relays are installed adjacent to one another on the mounting strip with the captive mounting screws provided. Rows of relays on mounting strip form their own wiring trough.

No.	Relays Per Strip	List Each
700-M4	4	$ 4.00
700-M8	8	6.00
700-M12	12	9.00
700-M16	16	11.00
700-M32	32	23.00

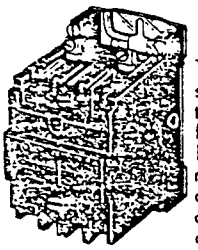
Front Deck – Can be attached to Bulletin 700 4 pole or Bulletin 700DC 3 pole Type N relays and Bulletin 700 or Bulletin 700DC 2 pole Type NM relays. Provides up to 4 additional convertible poles – without changing the mounting area.

No.	Front Deck With	List Each
700-NA20	2 Contact Cartridges	$16.00
700-NA40	4 Contact Cartridges	32.00

ALLEN-BRADLEY BULLETIN 700 TYPE R-RM 300 VOLT CONTROL RELAYS

Sealed Contacts

Open Type



4 Pole Type R Relay

The Type R sealed switch relay is an industrial type relay, designed for high contact reliability in dust and contaminant laden atmospheres, as well as for low power and dry circuits. It is available with from one to eight electrically isolated contacts in any combination of normally open or normally closed contacts. The mounting and wiring are identical to the Type N 300 volt control relay. Coils are available for all standard voltages both AC and DC up to 300 volts. Consult the factory for other than standard voltages. The total input to the coil is 6.5 volt-amperes. **Specify voltage and frequency.** The Type RM is a magnetic latching relay which has bi-stable sealed contact cartridges. The coil module contains two coil windings – one to latch the contacts and the other to reset the contacts. Both coils may be energized at the same time. To insure operation of all contacts, the latch and reset signals should be applied for at least 50 milliseconds. The color coded contact cartridges contain a single sealed switch in a controlled gas atmosphere. The contacts are made of tungsten to provide long life and have a full NEMA B300 AC contact rating, as well as a NEMA P300 DC current rating.

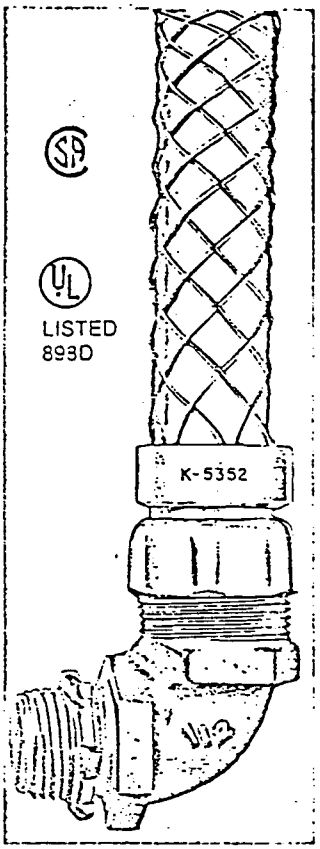
No. of Poles	Contacts NO	Contacts NC	Electrically Held AC Relay Only No.*	Electrically Held AC Relay Only List	Electrically Held DC Relay Only No.*	Electrically Held DC Relay Only List	Magnetic Latching AC Relay Only No.*	Magnetic Latching AC Relay Only List	Magnetic Latching DC Relay Only No.*	Magnetic Latching DC Relay Only List
			700–		700DC–		700–		700DC–	
0	0	0	R000-	$64.00	R000-	$44.00	RM000-	$168.00	RM000-	$128.00
2	2	0	R200-	104.00	R200-	84.00	RM200-	228.00	RM200-	188.00
2	1	1	R110-	108.00	R110-	88.00	RM110-	228.00	RM110-	188.00
2	0	2	R020-	112.00	R020-	92.00	RM020-	228.00	RM020-	188.00
3	3	0	R300-	120.00	R300-	100.00	RM300-	254.00	RM300-	214.00
3	2	1	R210-	124.00	R210-	104.00	RM210-	254.00	RM210-	214.00
3	1	2	R120-	128.00	R120-	108.00	RM120-	254.00	RM120-	214.00
3	0	3	R030-	132.00	R030-	112.00	RM030-	254.00	RM030-	214.00
4	4	0	R400-	136.00	R400-	116.00	RM400-	280.00	RM400-	240.00
4	3	1	R310-	140.00	R310-	120.00	RM310-	280.00	RM310-	240.00
4	2	2	R220-	144.00	R220-	124.00	RM220-	280.00	RM220-	240.00
4	1	3	R130-	148.00	R130-	128.00	RM130-	280.00	RM130-	240.00
4	0	4	R040-	152.00	R040-	132.00	RM040-	280.00	RM040-	240.00
5	5	0	R500-	152.00	R500-	132.00	RM500-	306.00	RM500-	266.00
5	4	1	R410-	156.00	R410-	136.00	RM410-	306.00	RM410-	266.00
5	3	2	R320-	160.00	R320-	140.00	RM320-	306.00	RM320-	266.00
5	2	3	R230-	164.00	R230-	144.00	RM230-	306.00	RM230-	266.00
5	1	4	R140-	168.00	R140-	148.00	RM140-	306.00	RM140-	266.00
5	0	5	R050-	172.00	R050-	152.00	RM050-	306.00	RM050-	266.00
6	6	0	R600-	168.00	R600-	148.00	RM600-	332.00	RM600-	292.00
6	5	1	R510-	172.00	R510-	152.00	RM510-	332.00	RM510-	292.00
6	4	2	R420-	176.00	R420-	156.00	RM420-	332.00	RM420-	292.00
6	3	3	R330-	180.00	R330-	160.00	RM330-	332.00	RM330-	292.00
6	2	4	R240-	184.00	R240-	164.00	RM240-	332.00	RM240-	292.00
6	1	5	R150-	188.00	R150-	168.00	RM150-	332.00	RM150-	292.00
6	0	6	R060-	192.00	R060-	172.00	RM060-	332.00	RM060-	292.00
7	7	0	R700-	184.00	R700-	164.00	RM700-	358.00	RM700-	318.00
7	6	1	R610-	188.00	R610-	168.00	RM610-	358.00	RM610-	318.00
7	5	2	R520-	192.00	R520-	172.00	RM520-	358.00	RM520-	318.00
7	4	3	R430-	196.00	R430-	176.00	RM430-	358.00	RM430-	318.00
7	3	4	R340-	200.00	R340-	180.00	RM340-	358.00	RM340-	318.00
7	2	5	R250-	204.00	R250-	184.00	RM250-	358.00	RM250-	318.00
7	1	6	R160-	208.00	R160-	188.00	RM160-	358.00	RM160-	318.00
7	0	7	R070-	212.00	R070-	192.00	RM070-	358.00	RM070-	318.00
8	8	0	R800-	200.00	R800-	180.00	RM800-	384.00	RM800-	344.00
8	7	1	R710-	204.00	R710-	184.00	RM710-	384.00	RM710-	344.00
8	6	2	R620-	208.00	R620-	188.00	RM620-	384.00	RM620-	344.00
8	5	3	R530-	212.00	R530-	192.00	RM530-	384.00	RM530-	344.00
8	4	4	R440-	216.00	R440-	196.00	RM440-	384.00	RM440-	344.00
8	3	5	R350-	220.00	R350-	200.00	RM350-	384.00	RM350-	344.00
8	2	6	R260-	224.00	R260-	204.00	RM260-	384.00	RM260-	344.00
8	1	7	R170-	228.00	R170-	208.00	RM170-	384.00	RM170-	344.00
8	0	8	R080-	232.00	R080-	212.00	RM080-	384.00	RM080-	344.00

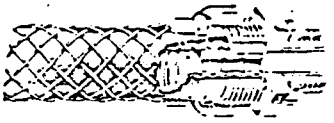
* – The catalog number as listed is not complete. To complete the catalog number, replace the dash at the end with a voltage and frequency identification number selected from the table below.

Type of Relay	Hertz	Coil Volts 24	32	48	64	110	115-125	120	208	220	230-250	240
AC	60	A24	A32	A48	A64	–	–	A1	A20	–	–	A2
	50	B24	B32	B48	B64	A1	–	–	B20	A2	–	–
DC	–	Z24	Z32	Z48	Z64	–	Z1	–	–	–	Z2	–

KELLEMS®
SEALTITE® CONDUIT GRIPS
WITH THOMAS AND BETTS FITTINGS

HUBBELL

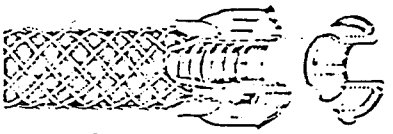




Standard Liquid-Tight Fittings for Machine Tool Wiring

or

For JIC boxes. Use New Chase Liquid Tight Connectors



FITTINGS MEET ALL CODE REQUIREMENTS

Take up less space in box than conventional connectors. Tighten from outside enclosure.

NEVER-FAIL MOISTURE SEAL

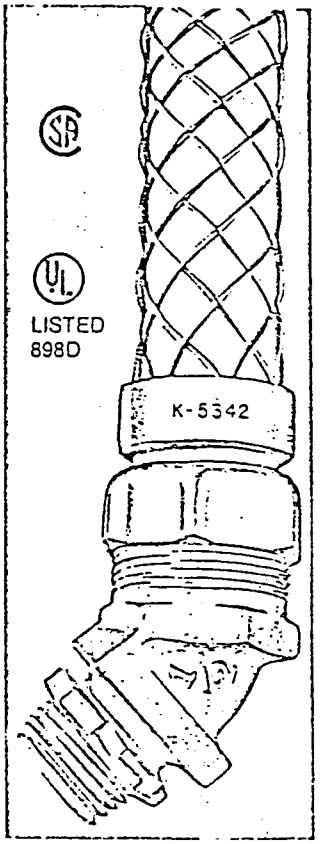
Exclusive design and construction features provide positive moisture-proof sealing. Nylon sealing gland covers a wide area—eliminates damage to the conduit jacket.

EXCEEDS U.L. GROUND AND STRENGTH REQUIREMENTS

The screw-in ground cone is forced against the connector body as the gland nut is tightened. The result is less than a 12 milli-volt drop to ground. This type of seal has twice the pullout strength required by U.L. Standards.

BUILT-IN INSULATION

Lines the entire throat of the connector. Eliminates the necessity of screwing a separate insulation bushing onto the thread length. Protects conductor insulation from abrasion due to vibration, thermal expansion and contraction.

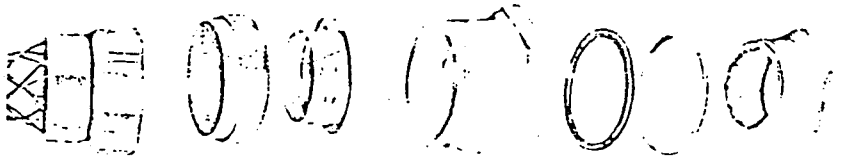


Dimensions —Inches—		90° ANGLE WITH MALE FITTING				45° ANGLE WITH MALE FITTING			
		INSULATED		NON-INSULATED		INSULATED		NON-INSULATED	
Trade Size	Mesh Length†	Part Number	Description	Part Number	Description	Part Number	Description	Part Number	Description
*3/8	3	074-06-061	K-5351	074-06-041	K-5251	074-06-088	K-5341	074-06-031	K-5241
1/2	3-1/2	074-06-062	K-5352	074-06-042	K-5252	074-06-089	K-5342	074-06-032	K-5242
3/4	4	074-06-063	K-5353	074-06-043	K-5253	074-06-090	K-5343	074-06-033	K-5243
1	5	074-06-064	K-5354	074-06-014	K-5254	074-06-091	K-5344	074-06-034	K-5244
1-1/4	6	074-06-065	K-5355	074-06-045	K-5255	074-06-092	K-5345	074-06-035	K-5245
1-1/2	6-3/4	074-06-066	K-5356	074-06-046	K-5256	074-06-093	K-5346	074-06-036	K-5246
2	8	074-06-067	K-5357	074-06-047	K-5257	074-06-094	K-5347	074-06-037	K-5247
2-1/2	9-3/4	074-06-068	K-5358	074-06-048	K-5258	074-06-095	K-5348	074-06-038	K-5248
3	11	074-06-069	K-5359	074-06-049	K-5259	074-06-096	K-5349	074-06-039	K-5249
4	14	074-06-070	K-5360	074-06-050	K-5260	074-06-097	K-5350	074-06-040	K-5250

*Fitting thread diameter is 1/2" for 3/8" trade size conduit.

†Mesh lengths are approximate.

CHASE SPACE-SAVER CONNECTOR



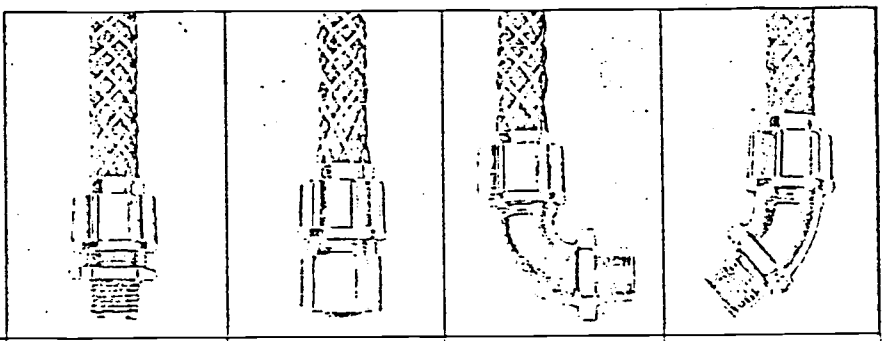
GRIP CONNECTORS ARE EASY TO INSTALL

1. Remove Chase Nipple from body. O Ring remains seated on nipple.
2. Slip Grip (A) over Sealtite conduit. Push end of Grip against fittings to enlarge "basket."
3. Slide nylon gland (B) over Sealtite conduit – tapered end out towards brass gr[illegible]d cone.
4. Screw brass gr[illegible]d cone (C) securely into the end of the Sealtite conduit.
5. Slide Grip toward open end of conduit until nylon makes contact with brass ground cone.
6. Place thread end of nipple (E) through knock-out from inside box.
7. Spin the steel body (D) onto the nipple threads. Tighten body with pliers or wrench.
8. Engage threads of gland nut (A) and fitting body (D) and tighten with a wrench. Action of gland nut compresses nylon gland evenly for liquid tight seal.

KELLEMS®
DELUXE CORD GRIPS

HUBBELL

LISTED
899D

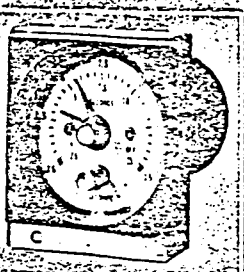


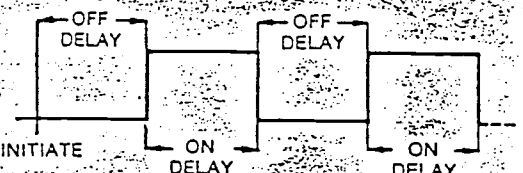
THD. Size N.P.T.	Grip Diameter Range -Inches-	MALE THREAD Part Number	MALE THREAD Description	FEMALE THREAD Part Number	FEMALE THREAD Description	90° MALE THREAD Part Number	90° MALE THREAD Description	45° MALE THREAD Part Number	45° MALE THREAD Description
3/8"	.250— .312	074-01- 001	CG-305	074-01- 036	CG-305F	074-01- 071	CG-305-90		
	.312— .375	074-01- 002	CG-306	074-01- 037	CG-306F	074-01- 072	CG-306-90		
	.375— .437	074-01- 003	CG-307	074-01- 038	CG-307F	074-01- 073	CG-307-90		
1/2"	.187— .250	074-01- 004	CG-404	074-01- 039	CG-404F	074-01- 074	CG-404-90	074-01-1235	CG-404-45
	.250— .375	074-01- 006	CG-406	074-01- 041	CG-406F	074-01- 076	CG-406-90	074-01-1236	CG-406-45
	.375— .500	074-01- 008	CG-408	074-01- 043	CG-408F	074-01- 078	CG-408-90	074-01-1021	CG-408-45
	.500— .625	074-01- 010*	CG-410*	074-01- 045	CG-410F	074-01- 080*	CG-410-90*	074-01-1237*	CG-410-45*
	.625— .750	074-01-1247*	CG-412*						
	.750— .875	074-01-1248*	CG-414*						
3/4"	.187— .250	074-01- 011	CG-604	074-01- 046	CG-604F				
	.250— .375	074-01- 013	CG-606	074-01- 048	CG-606F				
	.375— .500	074-01- 015	CG-608	074-01- 050	CG-608F	074-01- 081	CG-608-90	074-01-1238	CG-608-45
	.500— .625	074-01- 017	CG-610	074-01- 052	CG-610F	074-01- 083	CG-610-90	074-01-1049	CG-610-45
	.625— .750	074-01- 018	CG-612	074-01- 053	CG-612F	074-01- 084	CG-612-90	074-01-1051*	CG-612-45*
	.750— .875	074-01-1249*	CG-614*	074-01-1268*	CG-614F*	074-01-1275*	CG-614-90*	074-01-1239*	CG-614-45*
1"	.375— .500	074-01-1195	CG-808	074-01-1196	CG-808F	074-01-1197	CG-808-90	074-01-1195	CG-808-45
	.500— .625	074-01- 019	CG-810	074-01- 054	CG-810F	074-01- 085	CG-810-90	074-01-1053	CG-810-45
	.625— .750	074-01- 021	CG-812	074-01- 056	CG-812F	074-01- 087	CG-812-90	074-01-1055	CG-812-45
	.750— .875	074-01- 023	CG-814	074-01- 058	CG-814F	074-01- 089	CG-814-90	074-01-1057	CG-814-45
	.875—1.000	074-01- 025	CG-816	074-01- 060	CG-816F	074-01- 091*	CG-816-90*	074-01-1199*	CG-816-45*
	1.000—1.125	074-01-1250*	CG-818*	074-01-1269*	CG-818F*	074-01-1229*	CG-818-90*	074-01-1240*	CG-818-45*
	1.125—1.250	074-01-1028*	CG-820*						
	1.250—1.375	074-01-1029*	CG-822*						
1 1/4"	.750— .875	074-01-1251	CG-1014	074-01-1270	CG-1014F	074-01-1230	CG-1014-90	074-01-1241	CG-1014-45
	.875—1.000	074-01- 026	CG-1016	074-01- 061	CG-1016F	074-01- 107	CG-1016-90	074-01-1022	CG-1016-45
	1.000—1.125	074-01- 027	CG-1018	074-01- 062	CG-1018F	074-01- 108	CG-1018-90	074-01-1059	CG-1018-45
	1.125—1.250	074-01- 028	CG-1020	074-01- 063	CG-1020F	074-01-1042*	CG-1020-90*	074-01-1060*	CG-1020-45*
	1.250—1.375	074-01-1178*	CG-1022*	074-01-1243	CG-1022F	074-01-1043*	CG-1022-90*	074-01-1061*	CG-1022-45*
1 1/2"	.750— .875	074-01-1252	CG-1214	074-01-1271	CG-1214F	074-01-1231	CG-1214-90	074-01-1242	CG-1214-45
	.875—1.000	074-01- 029	CG-1216	074-01- 064	CG-1216F	074-01-1044	CG-1216-90	074-01-1062	CG-1216-45
	1.000—1.125	074-01- 030	CG-1218	074-01- 065	CG-1218F	074-01-1045	CG-1218-90	074-01-1063	CG-1218-45
	1.125—1.250	074-01- 031	CG-1220	074-01- 066	CG-1220F	074-01-1046	CG-1220-90	074-01-1064	CG-1220-45
	1.250—1.375	074-01- 032	CG-1222	074-01- 067	CG-1222F	074-01-1047	CG-1222-90	074-01-1065	CG-1222-45
	1.312—1.437	074-01-1253	CG-1223						
	1.437—1.562	074-01-1254*	CG-1225*						
	1.562—1.687	074-01-1255*	CG-1227*						
	1.687—1.812	074-01-1256*	CG-1229*						
	1.750—1.875	074-01-1257*	CG-1230*						
2"	1.250—1.375	074-01-1258	CG-1622	074-01-1272	CG-1622F	074-01-1232	CG-1622-90		
	1.312—1.437	074-01-1259	CG-1623	074-01-1273	CG-1623F	074-01-1233	CG-1623-90		
	1.437—1.562	074-01- 033	CG-1625	074-01- 068	CG-1625F	074-01-1244	CG-1625-90		
	1.562—1.687	074-01- 034	CG-1627	074-01- 069	CG-1627F	074-01-1245	CG-1627-90		
	1.687—1.812	074-01- 035	CG-1629	074-01- 070	CG-1629F	074-01-1246	CG-1629-90		
	1.750—1.875	074-01-1260	CG-1630	074-01-1274	CG-1630F	074-01-1234*	CG-1630-90*		
	1.812—1.937	074-01-1261	CG-1631						
	1.937—2.062	074-01-1262*	CG-1633*						
	2.062—2.187	074-01-1263*	CG-1635*						
	2.187—2.312	074-01-1264*	CG-1637*						
	2.312—2.437	074-01-1265*	CG-1639*						
2 1/2"	1.688—1.812	074-01-1030	CG-2029						
	1.812—1.937	074-01-1031	CG-2031						
	1.937—2.062	074-01-1032	CG-2033						
	2.062—2.187	074-01-1033	CG-2035						
	2.187—2.312	074-01-1034	CG-2037						
	2.312—2.437	074-01-1266*	CG-2039*						
3"	1.688—1.812	074-01-1267	CG-2429						
	1.812—1.937	074-01-1035	CG-2431						
	1.937—2.062	074-01-1036	CG-2433						
	2.062—2.187	074-01-1037	CG-2435						
	2.187—2.312	074-01-1038	CG-2437						
	2.312—2.437	074-01-1039	CG-2439						
	2.437—2.625	074-01-1186	CG-2442						
	2.625—2.812	074-01-1187	CG-2445						
	2.812—3.000	074-01-1188	CG-2448						
	3.000—3.250	074-01-1189*	CG-2452*						

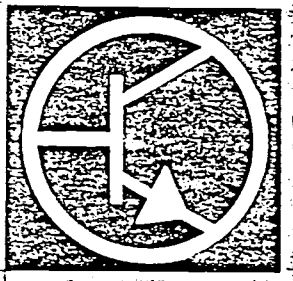
*Cable jacket may have to be stripped to pass through connector body.

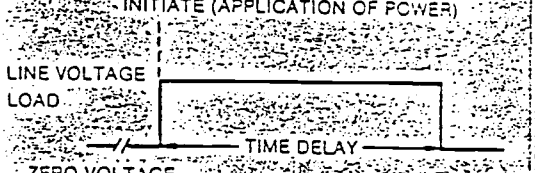
Helps you meet NEC 3 D-118 . 400-10 requirements.

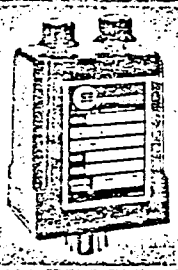
SOLID STATE TIMING CONTROLS

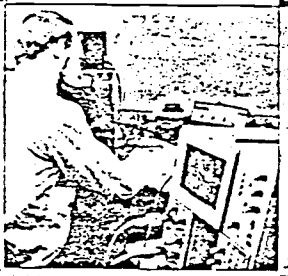


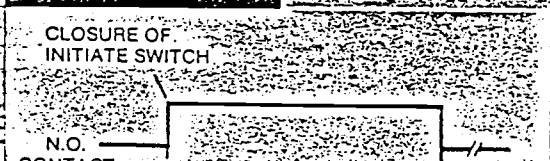


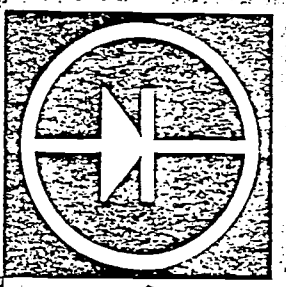


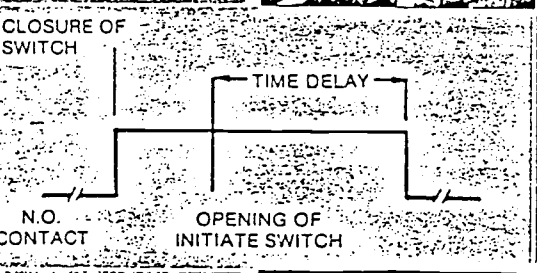


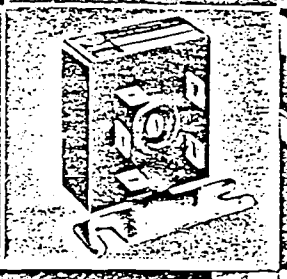


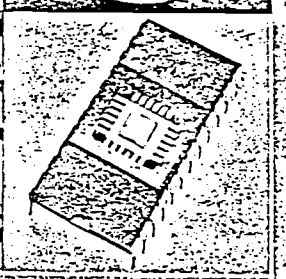


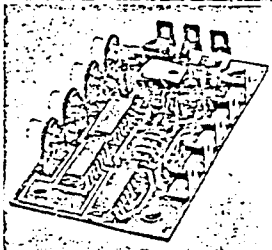


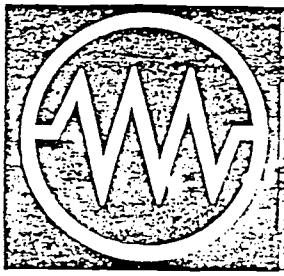


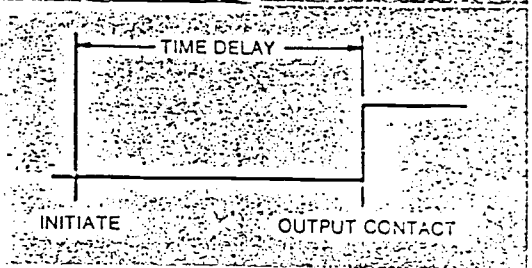












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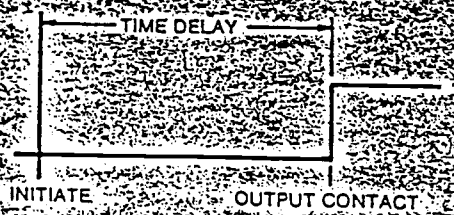
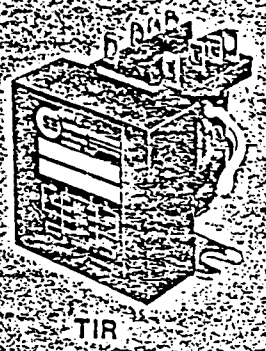
Section 3: Delay on Make Controls

Series TIR Solid State Time Delay Relay



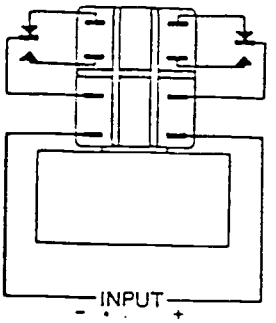


FEATURES:

- Surface mounting
- DPDT 10 amp output
- Factory fixed delays
- UL recognized
- CSA certified
- Approximate dimensions: 1-7/8"L x 2-1/16"H x 2-1/16"D

SPECIFICATIONS:

1. **Mode of Operation (Delay on Make)**
   Upon application of power to the input terminals the time delay cycle is initiated. At the end of the delay period, the output contacts transfer, either connecting or disconnecting the load. Reset is accomplished by removal of input power. NOTE: Series TIR is not subject to inherent false operation.
2. **Input**
   a. Voltage: Available in values from 24 VAC to 230 VAC and from 12 VDC to 110 VDC.
   b. Allowable variation from nominal: ±10%
   c. Frequency: 50/60 Hertz
3. **Time Delay Range**
   The TIR series time delays are preset to render a specific delay. The units are available with delays of 1 to 480 seconds at one second increments and less than 1 second at 1/10 second increments.
4. **Output**
   a. Type: Relay
   b. Contact rating: 10 amperes resistive at 115 VAC or 28 VDC
   c. Form: DPDT
   d. Life: Mechanical — 10,000,000 operations
   Under full load — 1,000,000 operations
5. **Physical Data**
   a. Mounting: Surface, panel mount
   b. Connection and termination: Quick connect/solder
   c. Weight: 4 ounces
   d. **Dimensions: See figures 7 & 8 on dimensional outline sheet, page 34.**
6. **Accuracy (applicable to time delays between 1 and 180 seconds only)**
   a. Repeat accuracy: Typical ±5%
   Maximum under fixed conditions ±7%
   Under extreme varying voltage and temperature conditions: ±10%
   b. Variation from nominal (fixed time delay): ±5%
7. **Time Delay Adjustment**
   a. Factory fixed
8. **Reset Time**
   a. During timing: 100 MS
   b. After time out: 100 MS
9. **Temperature Tolerance**
   a. Operating environment: -10° to +60°C
   b. Storage environment: -20° to +85°C
10. **Protection**
    a. Transient: Double the line voltage for one full cycle, repetitive
    b. Surge: 15 amperes for one half cycle, repetitive
    c. Inverse voltage protection provided on all D.C. units
11. **Connection Diagram**



12. **Ordering Information**
    When ordering follow the example below to obtain the part number of the time delay relay required.
    The example part number identifies:
    1. TIR Series Time delay relay
    2. Operating from 115 VAC input
    3. With a fixed delay of 30 seconds ±5%
    4. With a chassis mount/quick connect termination

Example Part Number TIR 115A 30 2 T

SERIES
INPUT VOLTAGE
(Obtainable from Specification #2)
TIME DELAY
(Obtainable from Specification #3)
TYPE MOUNTING
(Obtainable from Specification #5d)
TRANSIENT PROTECTION
(Obtained by adding the suffix "T" to the part number)

Series TIR is covered under the Underwriters Laboratories Recognized Component Program.
File No.: E38885A
Guide No.: ATNZ2
Certified under CSA File No. LR-28846, Guide No. 184-N-90.

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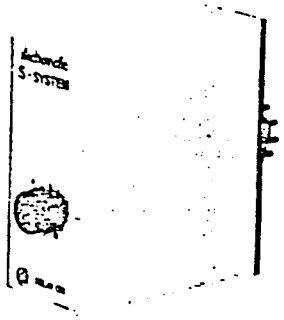
electromatic

S-SYSTEM

ELECTRONIC CONTROL- AND MONITORING MODULES



SM 115
Knob-adjustable

- Current metering relay for AC.
- Metering range: 0.1-500 A with current metering transformer.
- Knob-adjustable trip point.
- Latching at set level possible.
- 10 A SPDT output relay.
- LED-indication for relay on.
- AC- or DC supply voltage.

SPECIFICATIONS

Common technical data and ordering key
Pages 10–12.

Input voltage
Pins 5-7: 0.1-4 V.
Max. 50 V.
Pin 5 positive.

Hysteresis
App. 10 %.
The hysteresis can be extended to app. 75 % by connecting a resistor between pins 8-9. Resistor limits are 1 MΩ and 15 KΩ. The hysteresis increases by decreasing resistance.

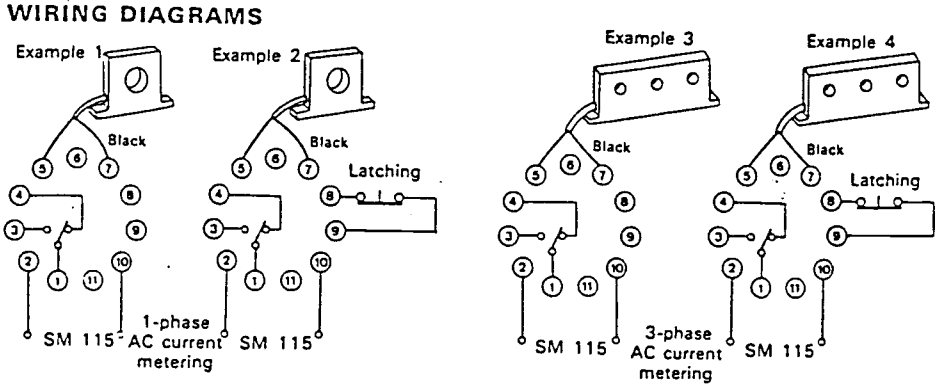
Latching
The relay shall latch at set level when pins 8 - 9 are interconnected.

AC measurements 1- or 3-phases
Are made in conjunction with one of the current metering transformers type MI or type MP. These transformers deliver an output voltage between 0.1 and 4 V being proportional with the current flowing in a conductor, drawn through the central hole of the transformer.

Accessories
Bases.
Hold down spring.
Mounting rack.
Base covers.
Front mounting bezel.

Current metering transformers, type MI and type MP.
See catalogue on accessories.

WIRING DIAGRAMS



MODE OF OPERATION

Example 1
AC CURRENT METERING (1-phase).
The relay operates when the current reaches the set value. The relay releases when the current drops at least 10 % below the set value (see hysteresis) or by disconnecting the supply voltage.

Example 2
AC CURRENT METERING (1-phase). LATCHING.
The relay operates when the current reaches the set value and then latches in operating position. The relay releases by removing the latch, i. e. by opening the contact between pins 8-9, provided that the current has dropped at least 10 % below the set value (see hysteresis), or by disconnecting the supply voltage.

Example 3
AC CURRENT METERING (3 phases).
The relay operates when the current in any of the phases reaches the set value. The relay releases when the current in all 3 phases drops at least 10 % below the set value (see hysteresis) or by disconnecting the supply voltage.

Example 4
AC CURRENT METERING (3 phases). LATCHING.
The relay operates when the current in any of the phases reaches the set value and then latches in the operating position. The relay releases by removing the latch, i. e. by opening the contact between pins 8-9, provided that the current in all 3 phases has dropped at least 10 % below the set value (see hysteresis), or by disconnecting the supply voltage.

OPERATION DIAGRAMS

Example 1-3

Supply voltage

Set value
- 10 %
Input voltage pins 5-7
Relay on

Example 2-4

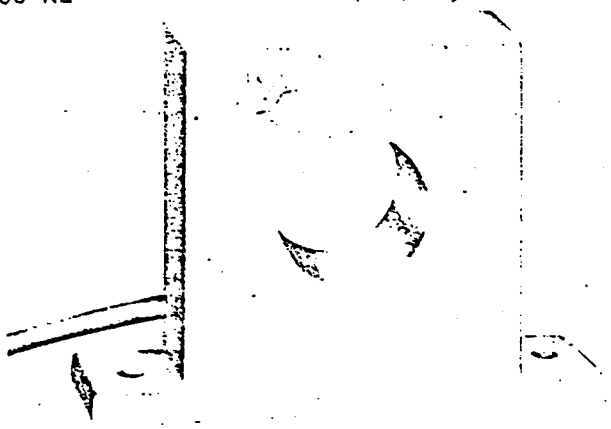
Supply voltage

Latching

Set value
- 10 %
Input voltage pins 5-7
Relay on

Single-phase current metering transformers for use in conjunction with S-SYSTEM type SM 115 - SG 195

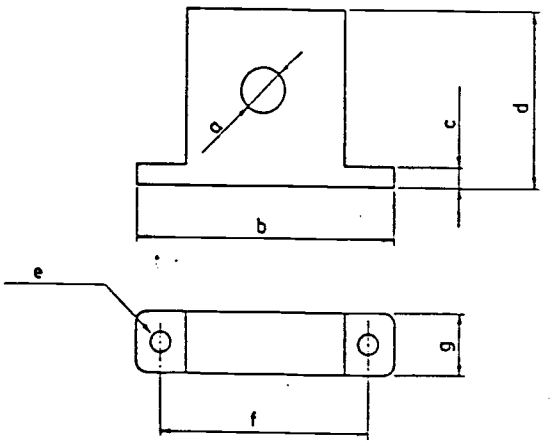
TYPE	MI 5	MI 20	MI 100	MI 500
Current range in conjunction with SM 115	0.5-5 A_{rms}	2-20 A_{rms}	10-100 A_{rms}	50-500 A_{rms}
Voltage output in conjunction with SM 115	0.1-4 V_{peak}	0.1-4 V_{peak}	0.1 4 V_{peak}	0.1-4 V_{peak}
Max. current	20 A	50 A	250 A	700 A
R_{out}	700 Ω	200 Ω	40 Ω	10 Ω
Power loss	< 100 mW/5 A	< 100 mW/20 A	< 0.5 W/100 A	< 6 W/500 A
Ambient temp.	-20°C to +60°C	-20°C to +60°C	-20°-c to +60°C	-20°-c to +60°C
Weight	70 grammes	70 grammes	270 grammes	270 grammes
Moulded connection cord	1 metre	1 metre	2 metres	2 metres
Material	ABS	ABS	ABS	ABS



MI 5 - MI 20
MI 100 - MI 500
JD 20
JD 100
JD 500

The voltage output is proportional with the current flowing in a conductor drawn through the central hole of the current metering transformer. It is possible to use the current metering transformers, for instance the MI 5, for measurements far below the nominal range by drawing the conductor more times - for instance 5 - through the central hole, resulting in the range 0.1-1.0 A_{rms}.

DIMENSIONAL DRAWINGS



Type	a	b	c	d	e	f	g
MI 5 MI 20	12	53	4	36	4.5	42.5	13
MI 100 MI 500 JD 20 JD 100 JD 500	27	95	7	68	5	78	20

DC current metering transformers
For use in conjunction with S-SYSTEM type SJ 125

Parameters / Type	JD 20	JD 100	JD 500
Current range nominal 1)	2 - 20 A	10 -100 A	50 - 500 A
Max. current (continuously at + 20°C)	22 A	110 A	550 A
Max. current (duration 5 s)	40 A	200 A	700 A
Ambient temperature	0 to + 40°C	− 20 to + 60°C	− 20 to + 60°C
Supply voltage (supplied from SJ 125)	12-24 VDC { + 15 %, − 10 %	12-24 VDC { + 15 %, − 10 %	12-24 VDC { + 15 %, − 10 %
Current consumption (typ.)	25 mADC	25 mADC	25 mADC
Current output	0 - 20 mADC	0 - 20 mADC	0 - 20 mADC
Tolerance of current output (typ.)	5 %	5 %	5 %
Temperature influence (related to + 20°C), typ.	± 0.1%/°C	± 0.1%/°C	± 0.1%/°C
Moulded connection cable, grey, 3 x 0.14 mm², 4 mm Ø	m	2 m	2 m
Material/colour, housing	Blue	ABS/Blue	ABS/Blue
Weight in grams (approx.)	300	300	300

1) The conductor on which you meter is drawn through the central hole of the current metering transformer. It is possible to meter currents below the nominal range by drawing the conductor through the hole more times. If the conductor is drawn through the central hole for instance 5 times, the metering transformer will register 5 A when the current in the conductor is 1 A. In any case, the direction of the current must match the direction indicated by an arrow on the current metering transformer which is connected to the S-system as shown on the catalouge sheet concerning SJ 125.

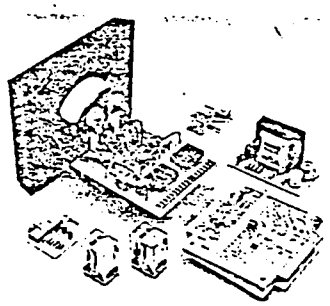
General Description
Indicating Controllers

Model 368 — DC inputs, Model 369 — AC inputs and Model 370 — Temperature (Thermocouple inputs)

OPERATIONAL DESCRIPTION

Jewell controllers are in constant use regulating critical processes for some of the world's largest corporations. The Jewell *Indicating Controller* (also referred to as Meter Relay) is one of the most versatile units in the industry. With the many options available, there are literally thousands of combinations that can be specified to meet your exact control requirements.

Plug-in output cards add to the versatility. The range, control action, or relay logic can be easily changed. This permits quick upgrading of your controller when your requirements change. The modular construction allows your local distribution/modification center to provide quick delivery of a controller custom engineered to your process requirements.



DESIGN VERSATILITY

SETPOINTS:
Single Setpoint (std.)
Dual Setpoint (option)
Slave Setpoint (option)

CONTROL ACTION:
On-Off (std.)
Time Proportioning (option)
Latching Relay with Manual Reset (option)
Control Disable (option)

RELAY ACTION:
Primary Relay energizes above setpoint (std).
Auxiliary Relay energizes below setpoint (std.)
Optional Relay Action Available

SETPOINT ADJUSTMENTS:
Push to Set (std.)
Internally Fixed Setpoint (option)
Screwdriver Adjustable Setpoint (option)

CONTROL OUTPUTS:
DPDT Relay Output (std.)
Solidstate (Triac) Output (option)

SUPPLY VOLTAGE:
120/208/240 VAC, 50-60 Hz Power Supply (std.)
24/120 VAC, 50-60 Hz (option)

DISPLAY:
Horizontal and Vertical Mounting (std.)
Special Dials (option)
Offset Ranges (option)
Suppressed Ranges (option)

MISCELLANEOUS:
Recorder Output (option)
AC Current Time Delay (option)

STANDARD FEATURES

COLD JUNCTION COMPENSATION - Temperature sensitive resistor compensates for changes in ambient temperature at thermocouple input terminals, providing accurate control over ENTIRE temperature operating range. Model 370 only.

CONTROL FUNCTION - Single setpoint with DPDT relay output.

CONTROL POINT SETABILITY - Each setpoint is adjustable over entire controller span. On dual setpoint units, each setpoint can be adjusted over entire range regardless of the position of the other.

DEAD SET POINTER - Each setpoint is equipped with a mechanical reference pointer which indicates position of control setting.

DESIGN FLEXIBILITY - Allows for complete interchangeability with older, "round barrel" designs. By adding (4) .156 DIA holes to 1/4 DIN opening, "round barreled" meter relay can also be used in cutout (Reference Drawing on page 41.)

DISPLAY - Rugged 4-1/2 inch, pivot and jewel meter.

FIELD CHANGEABLE RELAY LOGIC - Relay logic is easily changed by reversing two jumper wires. Both relays can be independently made to energize above or below setpoint.

FRONT MOUNTED L.E.D. - Indicates relay energized condition.

FRONT PANEL MOUNTING - 1/4 DIN housing mounts from front panel.

MODULAR PLUG-IN BOARDS - Permits quick upgrading should your requirements change and custom tailoring for your needs by our national network of modification centers.

PLUG IN RELAYS - Standard.

PLUG IN POWER SUPPLY - Standard Voltage 120, 208, 240 VAC at 50-60 Hz.

SCREW TYPE BARRIER STRIPS - Provide quick, easy wiring.

SETPOINT ADJUSTMENT - The control setpoint potentiometer is a push-to-engage type which prevents an inadvertent change of the setpoint position.

SLIDE MOUNT FEATURE - Permits removal from housing by loosening one front panel screw.

SOLID-STATE DEPENDABILITY - Solid-state design permits unit to continue controlling the process in the event the meter is damaged.

UPSCALE THERMOCOUPLE BREAK PROTECTION (FAILSAFE) - Safe process shutdown in the event Thermocouple opens. Model 370 only.

VERTICAL OR HORIZONTAL MOUNTING - Accommodates various installation requirements.

CUSTOM OPTIONS

AC CURRENT TIME DELAY - Internal circuitry prevents control action from occurring during initial current surges, for example, in motor starting applications. (Model 369 only).

CONTROL DISABLE SWITCH - Switch and associated circuitry permit immediate shutdown of process or equipment by disabling relay(s). Switch and function L.E.D. are mounted on front panel. Can be used with single or dual setpoint units. On dual setpoint units, it can be employed on primary, auxiliary or both setpoints.

DUAL SETPOINT CONTROL - Auxiliary (second) setpoint. Features push-to-set adjustment, and DPDT relay output. Supplied with second front panel mounted L.E.D. to display state of second setpoint relay.

EXTENDER BOARD - Accessory board plugs between controller housing and controller electronics exposing circuitry for servicing or fine tuning of proportioning parameters.

FIXED SETPOINT(s) - Setpoint is preset to predetermined value before shipment. Setpoint value(s) can be changed in field through internal adjustment. Provides tamper-proof control for single or dual setpoint units. On dual setpoint units, it can be employed on primary, auxiliary or both setpoints.

LATCHING RELAY WITH MANUAL RESET SWITCH - Upon relay actuation, relays latch (remain) energized regardless of process status. Relays will de-energize only when: 1) Panel mounted reset button is pushed and, 2) process condition has cleared. Used in high and low limit control. Relays will latch in energized condition only. Can be used on single or dual setpoint units. On dual setpoint units it can be employed on primary, auxiliary or both setpoints.

NON-STANDARD RELAY ACTION - (single or double setpoint). Any combination of relay action above or below setpoint is available.

OFFSET RANGES - Offsetting a range allows zero to be positioned anywhere on the dial. Allows for ranges such as (−20ma) to (+40ma), zero center or zero right.

RECORDER OUTPUT - Provides 0-1 VDC output on rear panel for connection to an auxiliary recorder. When supplied on a dual setpoint controller, the high setpoint relay output becomes SPDT. Auxiliary recorder must have minimum input impedance of 50,000 ohms. Recorder output cannot be used with triac output option on auxiliary (second) setpoint.

REMOTE SETPOINT OPTION - Toggle switch located on the instrument front panel may be set to "local" or "remote" setpoint adjustment position. Remote setpoint potentiometer is wired to rear terminals. Can be used only on single setpoint units. Consult factory.

SCREWDRIVER ADJUSTABLE SETPOINT - Replaces push-to-set knob(s) on front panel. Slotted potentiometer shaft is covered with a protective screw-on cap. Can be used on single or dual setpoint units. On dual setpoint units, it can be utilized on primary, auxiliary or both setpoints.

SLAVE SETPOINT - A second setpoint designed to track the adjustable primary setpoint by a specified percent of span. Internally adjustable from 0 to ±50 percent of span, it can be preset at the factory or adjusted in the field. The slaved setpoint will not function beyond the span extremes. The front panel mounted L.E.D. indicates the slave output relay in energized condition. Available as an option for single setpoint controller only.

SPECIAL DIALS - Available in special ranges with your company's logo or a special legend in single or multi color.

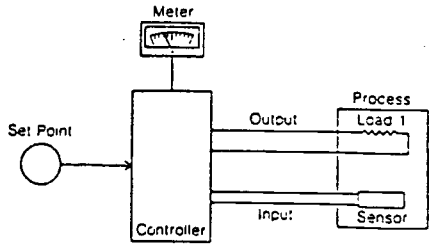
SUPPRESSED RANGES - Ranges can be suppressed up to 2 x span. Suppressing ranges increase resolution, and decrease input span. Since accuracy is rated as a percent of span, a decrease in span results in a decrease in accuracy tolerances. Example: Two controllers are set up to control a process at 150 DCV. Controller #1 has an input span from 0-200 VDC. At ±1 percent control point accuracy, the tolerance becomes ±2 volts. Controller #2 has an input span (suppressed) from 100 VDC to 200 VDC. At ±1 percent control point accuracy, the tolerance becomes ±1 volt.

TIME PROPORTIONING OUTPUT - When the process approaches the setpoint, the output automatically switches on and off, providng the right proportion of on time versus off time to keep the process at the control point. Proportional band is adjustable from 3 to 10 percent of span (shipped set at 6 percent unless otherwise specified) and cycle time adjustable from 2 to 20 seconds (shipped set at 6 seconds unless otherwise specified). Can be used on single or dual setpoint units. On dual setpoint units, it can be utilized on primary, auxiliary or both setpoints.

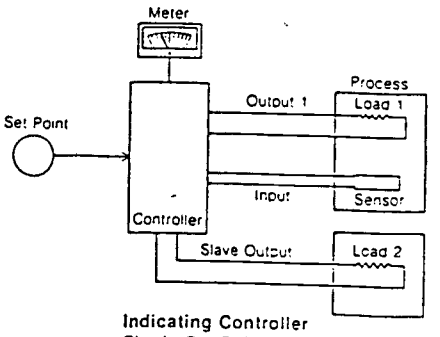
TOGGLE SWITCH AND POTENTIOMETER SETPOINTS - Replaces push-to-set potentiometer. Toggle switch is switched to "set" position for setpoint adjustment, and "read" position for monitoring process. Potentiometer is screwdriver adjustable only, covered with a protective screw-on cap. Consult factory.

TRIAC OUTPUT - A solid-state, zero crossing triac option is available for use in rapid switching situations. The zero crossing feature allows it to switch only when the A-C line cycle is passing through zero. Switching at low voltages, it prevents the generation of EMI. (For single or dual setpoints.)

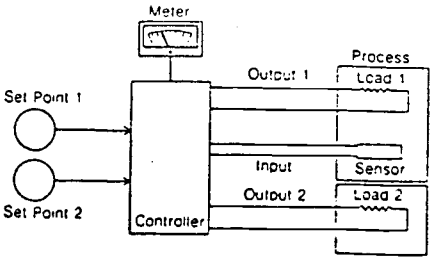
24 VAC POWER SUPPLY - Plug-in replacement for conventional power supply. Operating range 22 to 26 volts at 50-60 Hz.



Indicating Controller Single Set Point



Indicating Controller Single Set Point with Slave



Indicating Controller Double Set Point

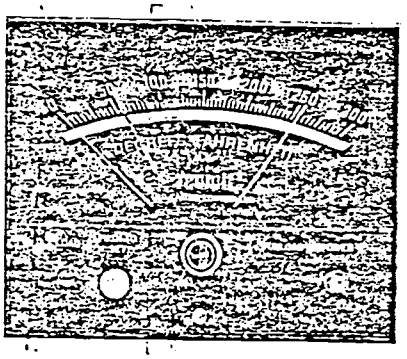
Model 370 Indicating Temperature Controller

The Model 370 Indicating Controller is designed to accept DC millivolt input spans as low as 8 DC MV from thermocouple types J, K, R, S and T. Upscale thermocouple break protection and cold junction compensation are standard features.

OPERATIONAL DESCRIPTION

The (DC MV) input is conditioned, amplified and displayed on the meter. A comparator (one for each setpoint) compares the amplified signal against a setpoint reference voltage which is internally generated upon adjusting the external setpoint knob to a given setpoint value.

When the amplified input signal reaches the setpoint reference voltage, the controller energizes or de-energizes the relay. The nature of the change in state of the relay depends upon the relationship between the amplified input signal and the setpoint reference voltage.



SPECIFICATIONS

CALIBRATION ACCURACY - ±1% of span for central 80% (at 25°C)

DEAD BAND (Hysteresis) - 0.5% of span

CONTROL POINT ACCURACY - ±1% of span

CONTROL FUNCTION - Single setpoint, on-off control

OUTPUT - DPDT relay rated at 5 amps 120 VAC maximum resistive load

RELAY ACTION - Relay energized above setpoint

OPERATING RANGE - 32°F-140°F (0°C-60°C)

METER RESPONSE TIME - 1 second max

SUPPLY VOLTAGE - 120/208/240 VAC, 50/60 Hz

POWER CONSUMPTION - 5 watts nominal

TERMINATION - Barrier strips on rear panel

PANEL CUTOUT - 3-5/8 in. x 3-5/8 in. (92 mm x 92 mm). See page 41.

DEPTH BEHIND PANEL - 5-3/8 in. (137 mm)

EXTERNAL THERMOCOUPLE RESISTANCE - 100 ohms max

CONSTRUCTION

Rugged model 45 pivot and jewel meter, see page 18 for construction. 1/4 DIN aluminum housing. Modular plug-in electronics.

STANDARD FEATURES & OPTIONS

See pages 24 through 25 for description of standard features and custom options.

APPLICATIONS INFORMATION

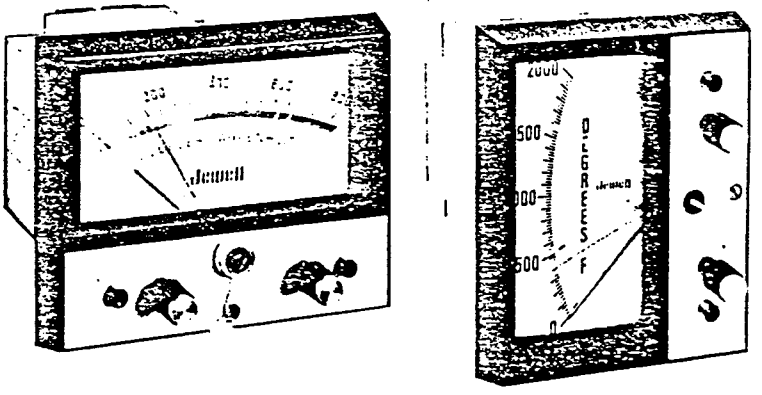
Food processing equipment
Heat treating ovens
Marking machinery
Wave soldering systems
Hot plates
Environmental chambers
Lab ovens
Kilns
Plastics processing
Refrigeration equipment
Heat sealing

TEMPERATURE RANGES

Standard Range	Thermocouple Type	Standard Range	Thermocouple Type
0-300°F	"J"	0-150°C	"J"
0-600°F	"J"	0-300°C	"J"
0-800°F	"J"	0-500°C	"J"
0-1000°F	"J"	0-800°C	"K"
0-1600°F	"K"	0-1000°C	"K"
0-2000°F	"K"	0-1500°C	"K"
0-2500°F	"K"		

Non-standard ranges available, consult factory or authorized Jewell distributor.

INDICATING CONTROLLER



VERSATILE SOLID-STATE METER RELAYS
FOR PROCESS APPLICATIONS

INSTALLATION AND OPERATING MANUAL

QUALITY • RELIABILITY • SERVICE

Jewell

KATY

ELECTRICAL INSTRUMENTS, INC.
Grenier Field, Manchester, N.H. 03108
(603)669-6400 Telex 94-3435

MODEL 368 DC RANGES MODEL 369 AC RANGES
MODEL 370 TEMPERATURE RANGES

SPECIFICATIONS

Calibration Accuracy:	±1% of span for central 80% (at 25°C); AC ranges ±3% of span for central 80% (at 25°C and 50 or 60 Hz)
Dead Band:	0.5% of span at 25°C
Coincidence:	±0.75% of span at 25°C
Control Function:	Single or double setpoints (on-off, or proportional band)
Setpoint Adjustability:	Single or double setpoints are adjustable over full scale
Standard Relay Action:	The low relay is energized above setpoint; the high relay is energized below setpoint (others optional)
Output:	DPDT relay for each setpoint
Relay Rating:	5 amps 120VAC for resistive loads
Operating Range:	32°F to 140°F (0° to 60°C)
Meter Response Time:	1 second maximum
Supply Voltage:	105/130, 180/225 or 210/260 volts, 50/60 Hz
Power Consumption:	5 watts nom.
Termination:	Barrier strips on rear panel
Panel Cutout:	3.638 ± .016 sq. in. 92.4 ± 0.4 sq. mm
Depth Behind Panel:	5.3 8 in. 136.5 mm

OPTIONS

Control Disable Switch:
Switch disables the output relays. Switch and function light are mounted on instrument front panel.

Latching with Manual Reset Switch:
(one or both relays) Upon relay activation, the relay remains activated regardless of pointer position until reset switch is pushed. Switch is mounted on instrument front panel.

Time Proportioning Output:
(single or double setpoints) When the process approaches the setpoint the output switches on and off automatically, providing the right proportion of on time vs. off time to keep the process at the control point. Proportional band is adjustable 3% to 10% (shipped set at 6% unless otherwise specified) and cycle time adjustable 2 to 20 seconds (shipped set at 6 seconds unless otherwise specified).

Fixed Setpoint:
(single or double setpoint units) Control function is on-off or time prop. Setpoint is preset at the desired level before shipment. This internal adjustment can be changed in the field when necessary. Setpoint function light is mounted on front panel.

Slave Setpoint:
This second setpoint is adjustable from 0 to ±50% of span. It is internally set at a specified differential before shipment and will then track the adjustable setpoint by this amount. (The control function is on-off. Slave will not operate beyond scale extremes.) The function light for this second setpoint is mounted on front panel.

Recorder Output:
The 0 to 1 VDC output is available at the rear terminals for connection to an auxiliary recorder which must have a minimum input impedance of 50,000 ohms. When supplied on a double setpoint controller, the high relay output is SPDT.

Solid State Switch (TRIAC):
(single or double setpoint units) Replaces conventional DPDT relay with a zero starting single pole normally open switch. Rating is 5 amps continuous up to 120 volts. Inrush capability 50 amps. Leakage current 5ma. Load and controller need not operate from the same power source.

Suppressed Ranges:
Available up to 2x span. For example, span is 75 with maximum suppression, dial would read 150 to 225.

Offset Ranges:
Zero can be positioned anywhere on dial.

Blank Dial:
Available with 30, 40, 50, 60, 75, or 80 divisions or completely blank.

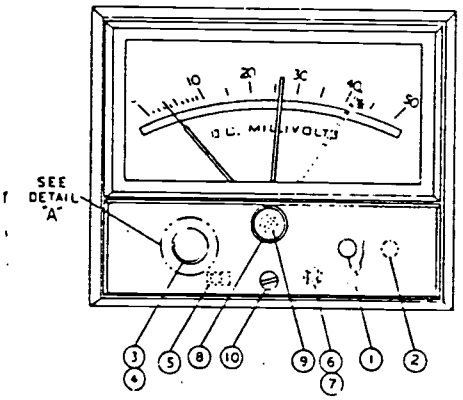
Special Dial:
Consult factory or modification center.

Non Standard Relay Action:
(single or double setpoint) Any combination of relay action above or below setpoint is available.

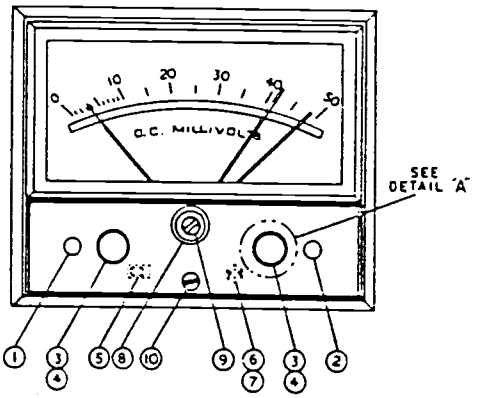
Screw Driver Setpoint Adjust:
(single or double setpoint) Replaces push-to-set knob on front panel. Slotted potentiometer shaft is covered with a protective screw-on cap. Push-to-set action is retained.

FRONT PANEL CONFIGURATIONS

SINGLE SETPOINT CONTROLLER

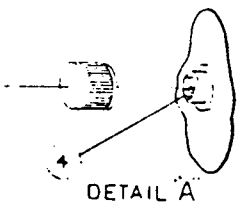


DOUBLE SETPOINT CONTROLLER



1 – L.E.D. (GREEN) FUNCTION LIGHT (LOWER SETPOINT)
* 2 – L.E.D. (RED)FUNCTION LIGHT (UPPER SETPOINT)
3 – CONTROL, SETPOINT, ADJUST (ELECT.)
4 – CONTROL, SETPOINT, SCREW DRIVER ADJUST (ELECT.)
5 – CONTROL ACTION DISABLE SWITCH
6 – L.E.D. (YELLOW) FUNCTION LIGHT (CONTROL DISABLE)
7 – UNLATCH SWITCH
* 8 – SETPOINT INDICATOR-GREEN (LOWER)
* 9 – SETPOINT INDICATOR-RED (UPPER)
10 – CHASSIS LOCKING DEVICE

*PART OF SLAVED UPPER SETPOINT OPTION AND INTERNALLY FIXED UPPER SETPOINT OPTION



DETAIL "A"
SCREW DRIVER ADJUST SET POINT

Unpacking

Remove the controller from the shipping case and inspect for shipping damage. Should the controller be damaged, notify your carrier immediately. Do not discard the packing container until it has been examined by your agent.

Mounting

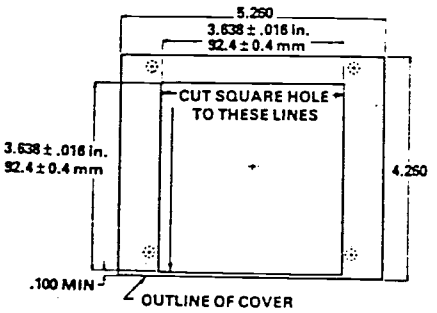
Installation and removal of the controller is accomplished from the front of the panel. Complete front mounting is possible by making electrical connection before installing case.

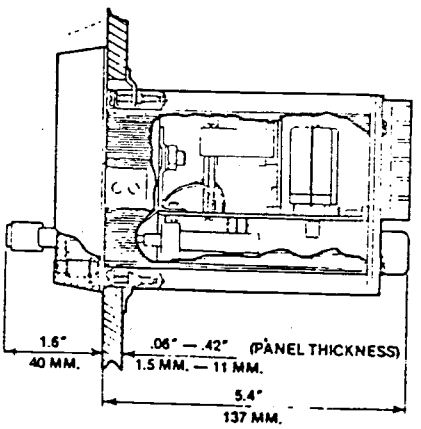
The controller is mounted into a standard 1/4 DIN panel cutout. See Fig. below. Remove the controller from the case by disengaging the chassis locking device. With the four clamp arms all the way to the rear (CCW rotation of locking screws), insert the case into the cutout until the stop brackets contact the panel. Secure the case to the panel by a clockwise rotation of the four locking screws. Insert the controller into the case and secure with the chassis locking device, while applying equal pressure to top and bottom of meter with thumb and fore-finger to insure uniform engagement of meter to case.

CAUTION

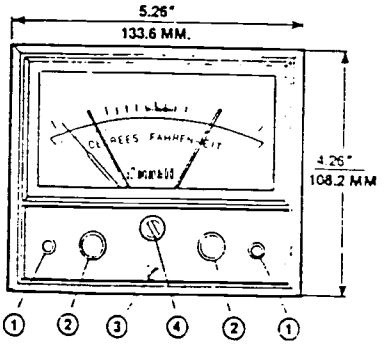
For increased accuracy when controller is mounted in a steel panel, remove the 12.4 K ohm resistor located on the meter barrel. This increases the sensitivity of the meter by the amount that the steel panel decreases it, thereby restoring initial accuracy.

DIMENSIONS





SIDE VIEW



1 — FUNCTION LIGHT
2 — SETPOINT CONTROL (PUSH TO SET)
3 — LOCKING SCREW
4 — REFERENCE SET POINTER KNOB

FRONT VIEW

Wiring

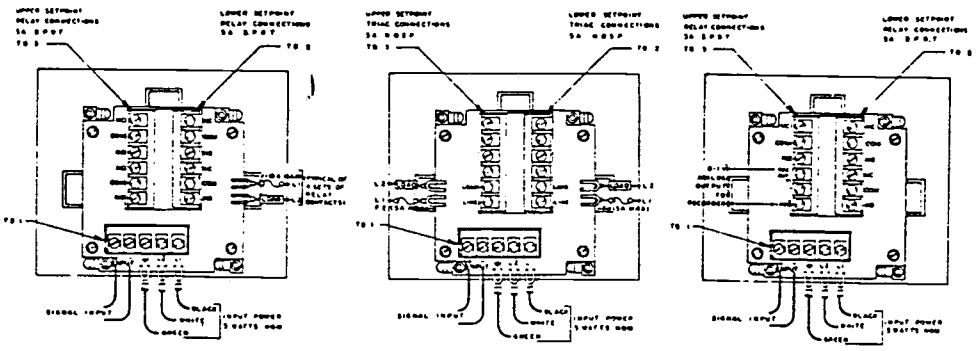
Captive wire clamping plates allow connections without need for hook, ring or other crimp terminals, but if desired, Thomas and Betts #RB2207 insulated terminals or equivalent may be used.

It is recommended that thermocouple wires be connected directly to terminal screws to assure accurate cold junction compensation.

CAUTION

Disconnect power before making wiring changes or connections.

CONTROLLER REAR PANEL WIRING



RELAY OUTPUT | TRIAC OUTPUT | RELAY OUTPUT WITH RECORDER OPTION

NOTES

A. An ARC suppression network across inductive loads (such as contactor coils) will increase relay contact life. A typical network would consist of a 0.1 mfd., 400 volt capacitor in series with a 100 ohm resistor.

B. Thermocouple lead resistance of up to 100 ohms may be used on the Model 370.

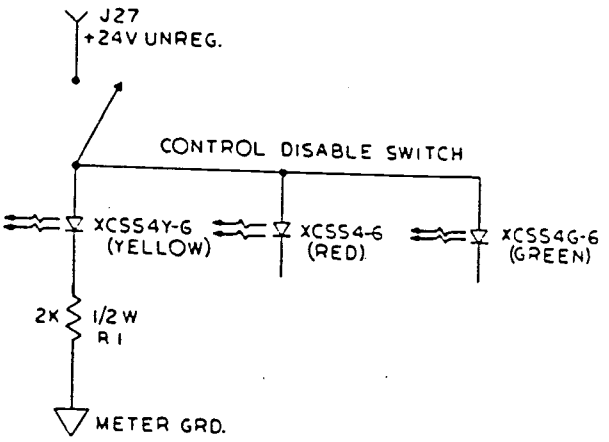
DESCRIPTION

The Jewell Indicating Controller is a potentiometric setting device. The control setpoint potentiometer is a push-to-engage type which will prevent an inadvertent change of the setpoint position.

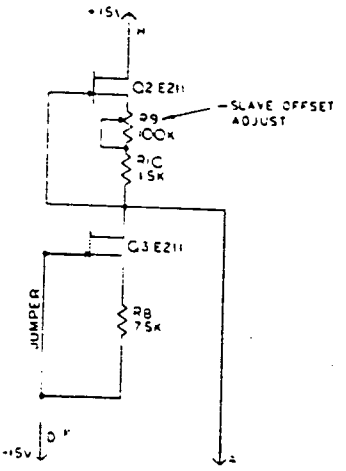
When the control setpoint knob is depressed, the meter pointer will display the location of the setpoint. The required setting is achieved by rotating the knob while depressed until the meter pointer reaches the desired level. When the knob is released, the meter pointer will display the input signal level. The location of the setpoint can be verified at any time by simply depressing the setpoint knob, taking care not to rotate the knob thereby changing the setpoint position.

For any given setpoint value, the input signal which has been amplified to drive the meter is compared electrically to an internally generated reference voltage to control one or both output relays. The LED function light mounted on the instrument front panel will illuminate when the output relay is energized.

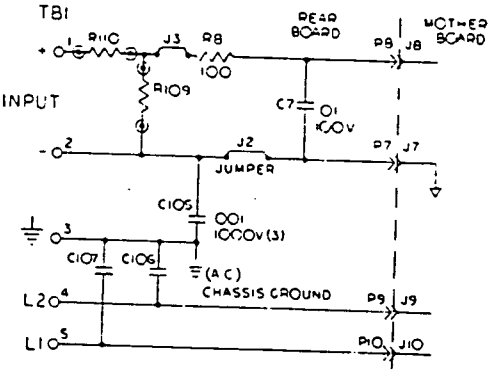
To provide a visual indication of the setpoint location at all times, the controller is equipped with a setpoint indicator for each setpoint. Once the setpoint has been electrically set, the appropriate indicator should be positioned directly over the setpoint so that its position can be seen at a glance.



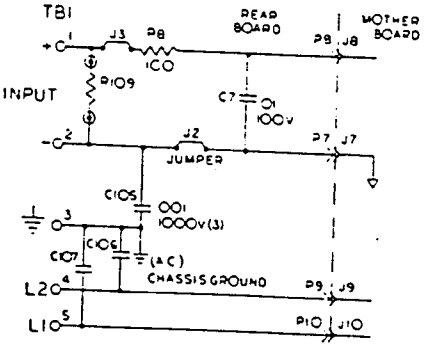
CONTROL DISABLE SCHEMATIC



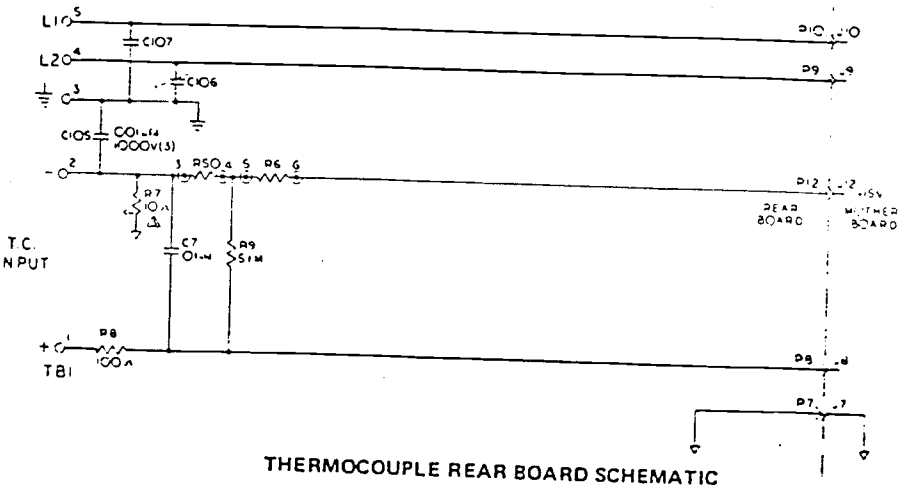
SLAVE SCHEMATIC



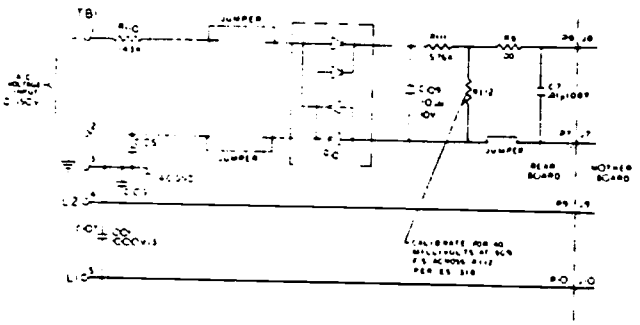
DC VOLTS AND MILLIVOLTS
REAR BOARD SCHEMATIC



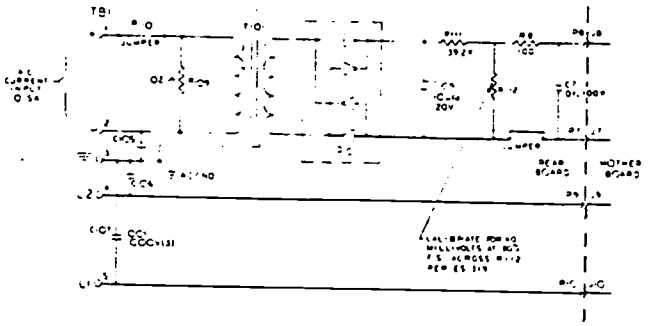
DC CURRENT REAR BOARD SCHEMATIC



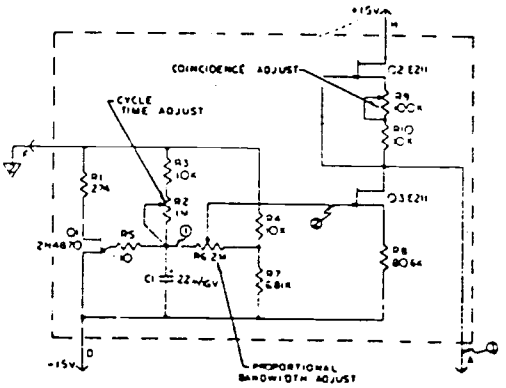
THERMOCOUPLE REAR BOARD SCHEMATIC



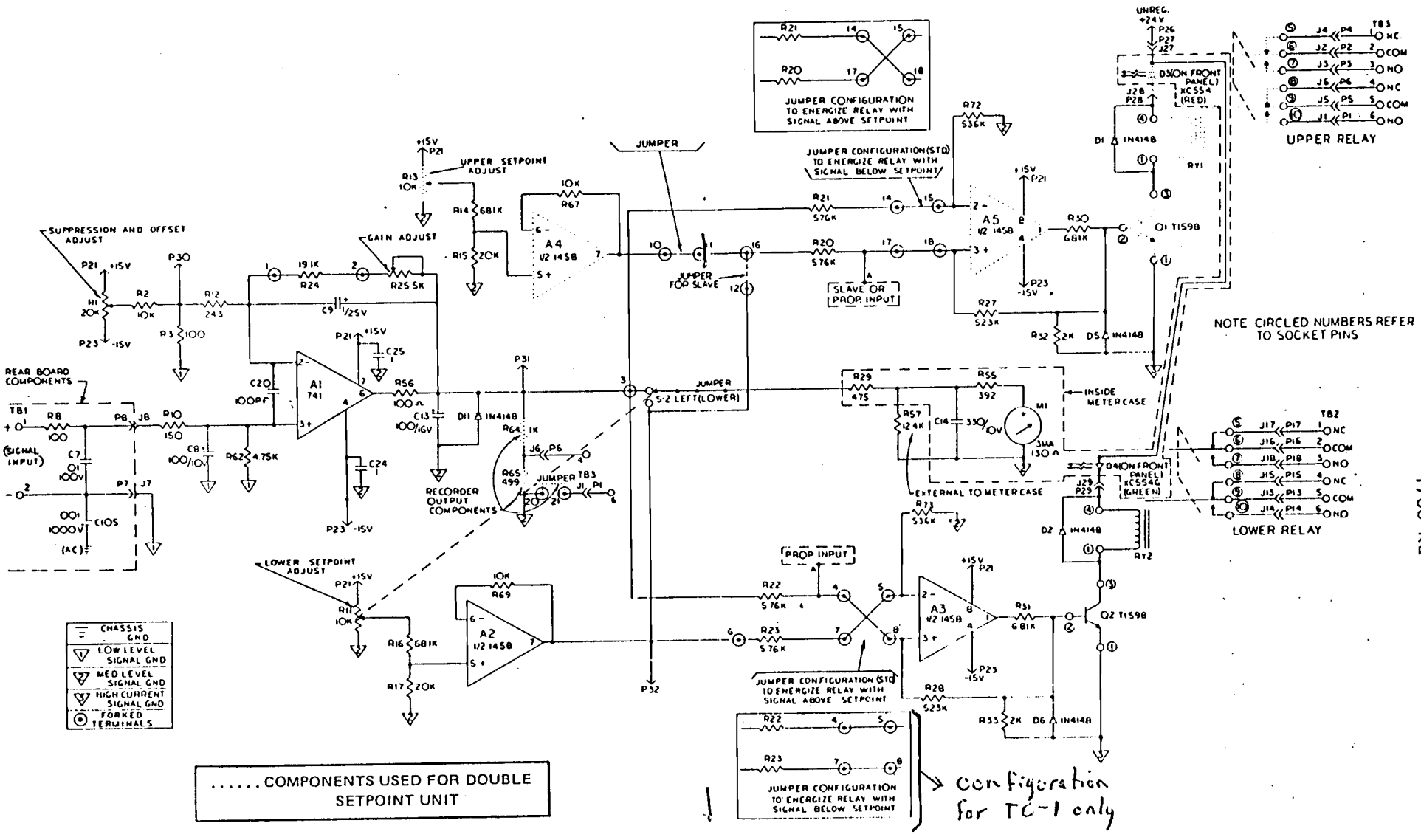
AC VOLTAGE REAR BOARD, SCHEMATIC



AC CURRENT REAR BOARD, SCHEMATIC



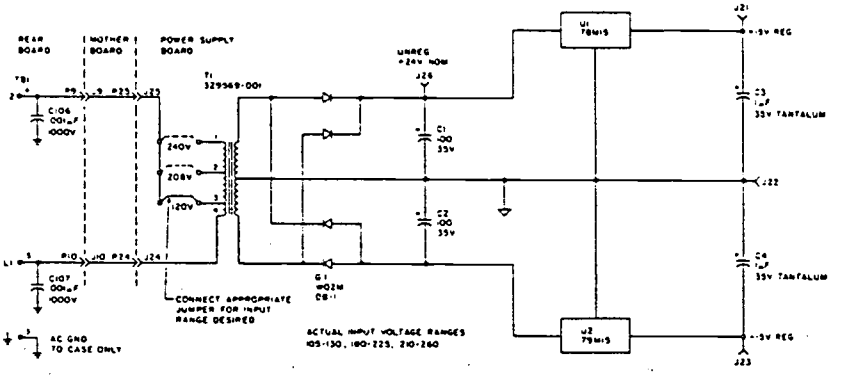
PROPORTIONING SCHEMATIC



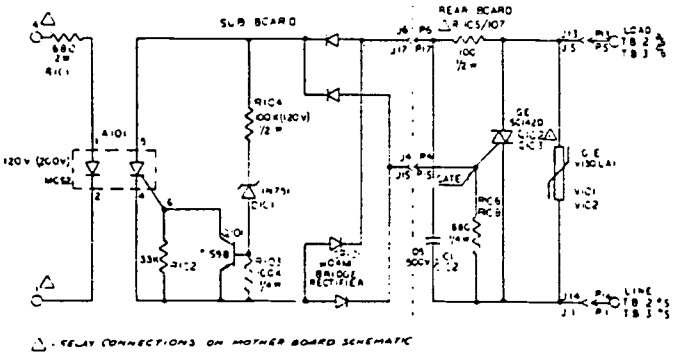
INDICATING CONTROLLER SCHEMATIC

1706-KE

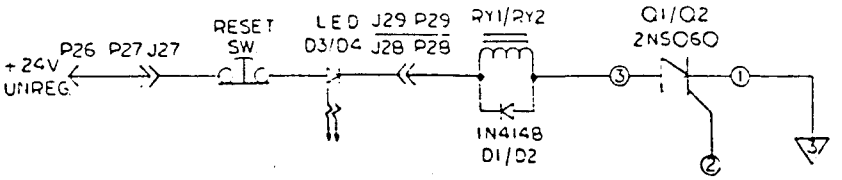
4/24/87, Rev. 0



± 15V D.C. POWER SUPPLY SCHEMATIC



TRIAC SCHEMATIC



NOTE 1-FIRST P/N-UPPER SETPOINT COMPONENT
SECOND P/N-LOWER SETPOINT COMPONENT

LATCHING SCHEMATIC

MECHANICAL ZERO ADJUSTMENT

The meter zero adjust screw is located at the rear of the meter case. To make this adjustment, disconnect power to the controller and remove controller from case.

NOTE: This adjustment should be made with the controller in its normal vertical or horizontal operating position.

CONTROLLER CALIBRATION

1. Disconnect power to the controller.
2. Remove controller from case and reinstall utilizing extender board kit, P/N 875429-001.
3. Connect power and signal source to TB1.
4. Adjust signal source to proper value corresponding to a selected value equal to 20 to 25% of full scale.
5. Adjust R1, located on the right rear edge of the P.C. board, for correct indication on meter.
6. Adjust signal source to proper value corresponding to a selected value equal to 75 to 80% of full scale.
7. Adjust R25, located on the right rear edge of the P.C. board, for correct indication on meter.

   NOTE: There is interaction between these adjustments; therefore, repeat Steps 4 through 7 until 0.5% of reading is achieved.
8. Disconnect power and signal source.
9. Remove extender board from case. Insert controller into case and secure with chassis locking device.

OPERATING VOLTAGE CONVERSION

Note: The controller is equipped with the following power supply. Power supply P/N875576-001 can be wired for operation on 120, 208 or 240 VAC.

1. Disconnect power to the controller.
2. Remove controller from case.
3. Remove power supply assembly from printed circuit board by unfastening holding screw and unplugging the assembly.
4. Connect jumper wire from fork terminal to appropriate hole location as shown in Figure a.
5. Reinstall power assembly into printed circuit board and secure with screw.
6. Insert controller into case and secure with chassis locking device.
7. Apply power and check for proper operation.

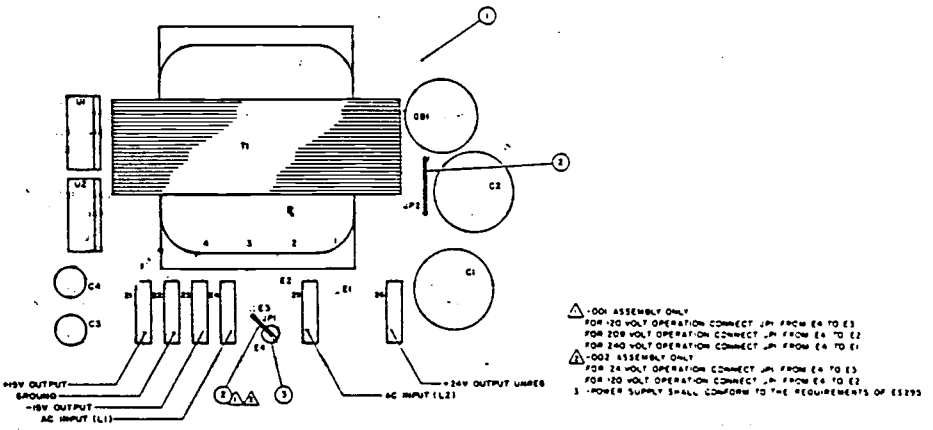


Figure (a) POWER SUPPLY, 120/208/240 VOLT

ADJUSTMENT OF SLAVE SETPOINT

1. Disconnect power to the controller.
2. Remove controller from case and reinstall utilizing extender board kit, P/N 875429-001.
3. Connect power and signal source to TB1.
4. Adjust low setpoint to mid scale; adjust signal source to desired slave setpoint level (above or below first setpoint).
5. Adjust R9 located on slave PC board (Figure c.). so that control action is effected.
6. Carefully readjust potentiometer until opposite control action is effected. (The setting of the slave setpoint is now established.)
7. Disconnect power and signal source.
8. Remove extender board from case. Insert controller in case and secure with chassis locking device.

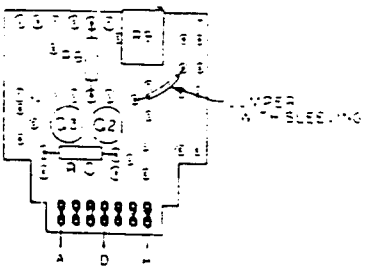


Figure (c)

ADJUSTMENT OF FIXED SETPOINTS

NOTE: R11 low and R13 high setpoint potentiometers are located on the underside of the printed circuit board directly behind the meter assembly.

1. Disconnect power to the controller.
2. Remove controller from case and reinstall utilizing extender board kit, P/N 875429-001.
3. Connect power and signal source to TB1.
4. Adjust signal source to required setpoint value, then adjust appropriate potentiometer until control action is effected.
5. Carefully readjust signal input level until function light changes state. This action will establish the setting of the preselected setpoint.
6. Disconnect power and signal source.
7. Remove extender board from case. Insert controller into case and secure with chassis locking device.

ADJUSTMENT OF TIME PROPORTIONING CIRCUIT

1. Disconnect power to the controller.
2. Remove controller from case and reinstall utilizing extender board kit, P/N 875429-001.
3. Connect controller to the process, apply power and adjust the setpoint to the desired level.
4. Bandwidth adjustment – the proportioning band can be adjusted from 3 to 10% of full scale. The 3% setting represents a high closed loop gain; whereas, the 10% represents a low closed loop gain. For a process which tends to be oscillatory or unstable, it is usually best to use a lower gain or a wider proportional band. Adjust R6 Figure d. (a cw rotation decreases system "Gain").
5. Cycle time adjustment – the frequency of the porportioning signal can be varied from 2 to 20 seconds per cycle. For a fast acting process, the cycle time should be adjusted down toward the 2 second limit; for a slow process, the cycle time should be set up toward the high end or near 20 seconds. Adjust R2 Figure d. (a cw rotation increases cycle time).
6. Coincidence adjustment – Adjust R9 to increase or decrease system operating point (coincidence). This adjustment is factory set for 33% on, 67% off, at operating point. This point is system dependent and proper adjustment will assure that the operating point is the same as adjusted setpoint value.

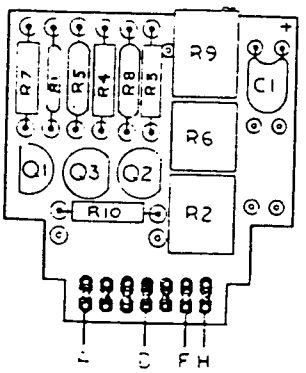


Figure (d)

TROUBLESHOOTING GUIDE

The first steps in troubleshooting are:

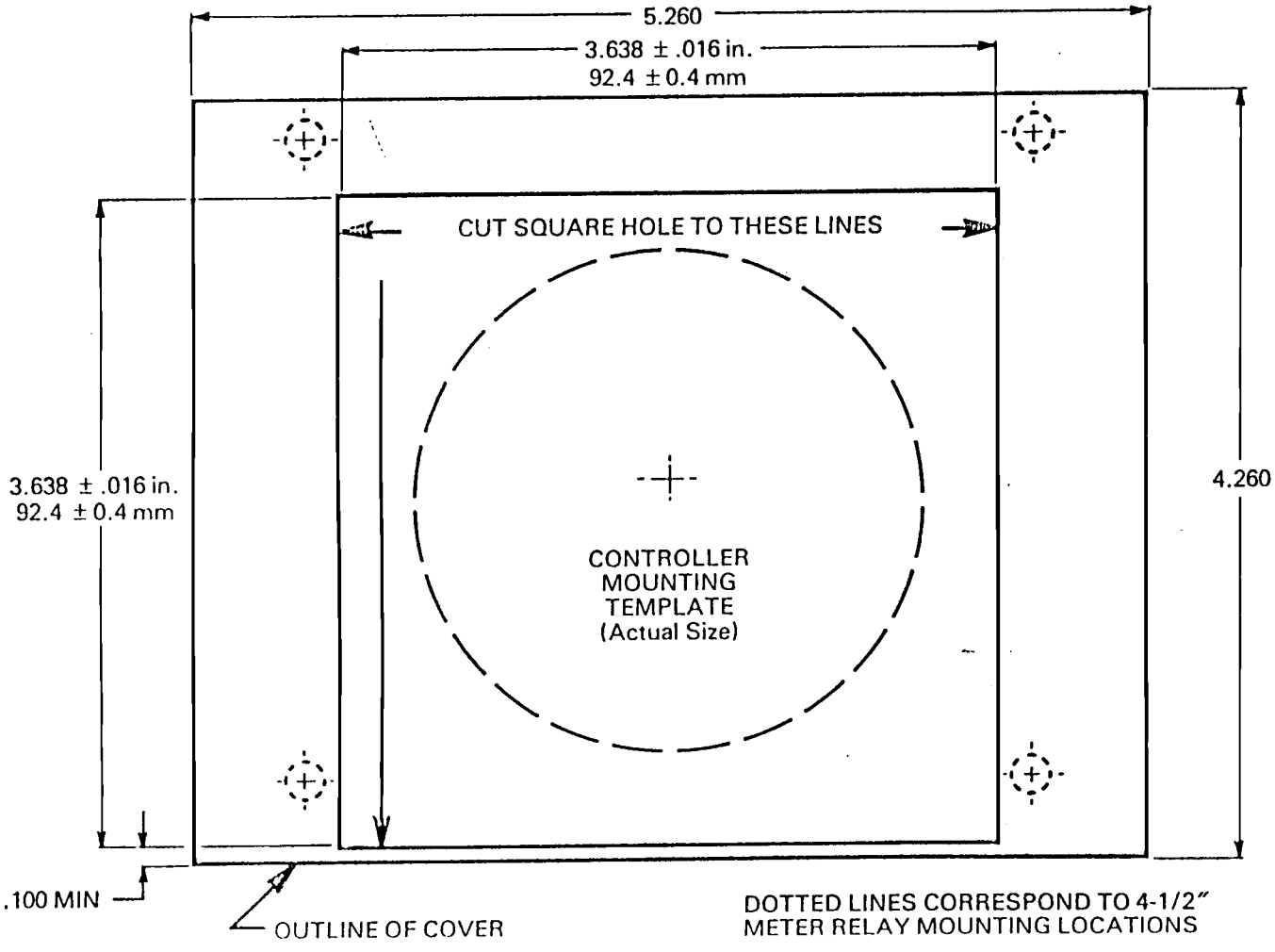
1. Remove controller from case and detach rear panel assembly. Plug rear panel assembly directly into mother board.
2. Assure that the appropriate power and signal are applied to TB1.
3. Verify that the power supply is not defective by checking output voltages as listed below.

+15 VDC	P21	+24 VDC	P26
-15 VDC	P23	GND	P22

4. Verify that relays are tight in sockets.
5. Verify that J27, J28 and J29 are attached as applicable. (Wires from meter case to mother board.)

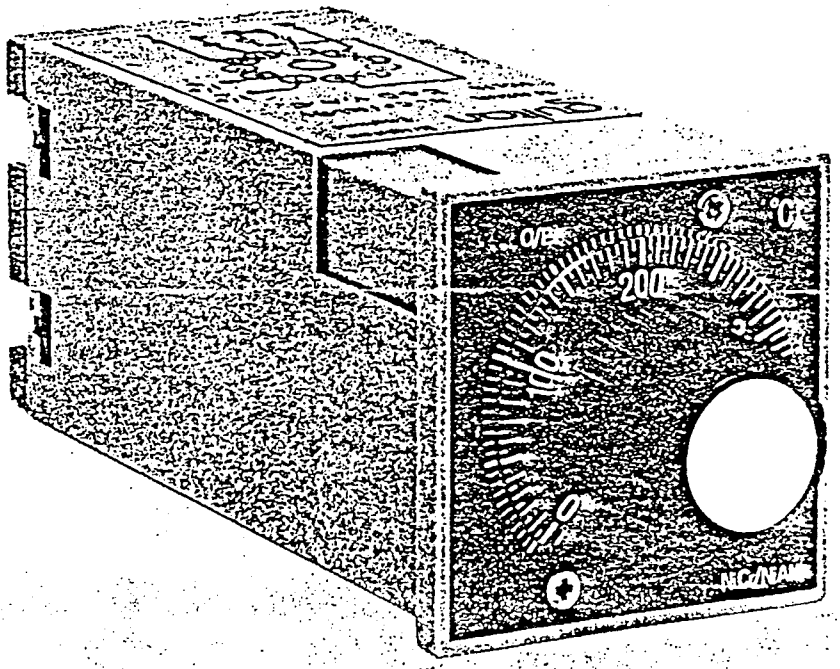
TROUBLESHOOTING GUIDE (Cont'd)

Symptom	Cause	Corrective Action
1. Meter does not respond to signal input at TB1-1 and TB1-2.		
a) No signal at P31 with input at J8.	a) No output from A1	a) Replace A1
b) Signal at P31.	b) Defective meter assembly	b) Correct meter discrepancy
2. Meter does not respond to push-to-set potentiometer (lower).		
a) No signal at wiper of R11.	a) Defective push-to-set potentiometer.	a) Replace PTS potentiometer assembly.
b) No signal at P32.	b) Defective A2	b) Replace A2/A3
c) No signal at meter & terminal when PTS (lower) is depressed.	c) Defective PTS switch	c) Replace PTS switch
d) Meter does not respond to signal at + terminal.	d) Defective meter assembly	d) Correct meter discrepancy
3. Meter does not respond to PTS potentiometer (upper).		
a) No signal at wiper of R13.	a) Defective PTS pot	a) Replace PTS assembly
b) No signal at forked terminal 10	b) Defective A4	b) Replace A4/A5
c) No signal at meter + terminal when PTS upper is depressed.	c) PTS switch defective	c) Replace PTS assembly
d) Meter does not respond to signal at + terminal.	d) Defective meter assembly	d) Correct meter discrepancy
4. Meter responds to PTS (lower) but appropriate control action does not occur.		
Test Condition: Adjust the input signal and PTS potentiometer so that the voltage at forked terminal 8 is 0.5 VDC greater than the voltage at forked terminal 5.		
a) The voltage of the cathode of D6 is negative.	a) A3 is defective	a) Replace A2/A3
b) The voltage at RY2-1 equals 24 VDC.	b) Q2 is defective	b) Replace Q2
c) The voltage at RY2-1 equals zero and the voltage at RY2-4 equals 22 to 24 VDC.	c) Relay 2 is defective	c) Replace Relay 2
d) The voltage at RY2-4 is nearly zero.	d) D4 (grn) is defective	d) Replace LED (grn)
5. Meter responds to PTS upper but appropriate control action does not occur.		
Test Condition: Adjust the input signal and PTS pot so that the voltage at forked terminal 18 is 0.5 VDC greater than the voltage at forked terminal 15.		
a) The voltage at the cathode of D5 is negative.	a) A5 is defective	a) Replace A4/A5
b) The voltage at RY1-1 equals 24 VDC.	b) Q1 is defective	b) Replace Q1
c) The voltage at RY1-1 equals zero and the voltage at RY1-4 is greater than 20 VDC.	c) Relay 1 is defective	c) Replace RY1
d) The voltage at RY2-4 is nearly zero.	d) D3 (red) is defective	d) Replace LED (red)
6. Temperature controller inoperative and controller works normally with a 50 MVDC rear panel.	Defective thermocouple rear panel.	Troubleshoot TC rear panel by doing the calibration and null.
a) Adjustment of R1 will not cause 20 to 25% deflection (9 to 13 MV between J8 and J7) and the voltage does not change at forked terminal 7.	a) Defective R1	a) Replace R1
b) The voltage changes at forked terminal 7, the amplifier output at forked terminal 6 is approximately +15 VDC and the voltage at forked terminal 2 is less than 1 volt.	b) Potentiometer R25 is defective	b) Replace R25
c) The voltage at forked terminal 2 is greater than 40% of the voltage at forked terminal 9.	c) A1 defective	c) Replace A1
7. Meter responds to PTS upper but appropriate control action does not occur with solid state output (upper)		
Test Condition: Adjust the input signal and PTS pot so that the voltage at forked terminal 14 is 0.5 VDC greater than the voltage at forked terminal 15.		
a) The voltage at the cathode of D5 is negative.	a) A5 is defective	a) Replace A4/A5
b) The voltage at RY1-1 equals 24 VDC.	b) Q1 is defective	b) Replace Q1
c) The voltage at RY1-1 equals zero and the voltage at RY1-4 is greater than 20 VDC.	c) Triac Gate circuit or Q103, Triac, defective	c) Replace Triac Gate circuit, if that does not correct malfunction, replace Q103, Triac
d) The voltage at RY2-4 is nearly zero.	d) D3 (red) is defective	d) Replace LED (red)
8. Meter responds to PTS (lower) but appropriate control action does not occur with solid state output (lower)		
Test Condition: Adjust the input signal and PTS potentiometer so that the voltage at forked terminal 8 is 0.5 VDC greater than the voltage at forked terminal 5.		
a) The voltage of the cathode of D6 is negative.	a) A3 is defective	a) Replace A2/A3
b) The voltage at RY2-1 equals 24 VDC	b) Q2 is defective	b) Replace Q2
c) The voltage at RY2-1 equals zero and the voltage at RY2-4 equals 22 to 24 VDC.	c) Triac Gate circuit or Q102, Triac, defective	c) Replace Triac Gate circuit, if that does not correct malfunction, replace Q102, Triac.
d) The voltage at RY2-4 is nearly zero.	d) D4 (grn) is defective	d) Replace LED (grn)


5.260
3.638 ± .016 in.
92.4 ± 0.4 mm
CUT SQUARE HOLE TO THESE LINES
3.638 ± .016 in.
92.4 ± 0.4 mm
4.260
CONTROLLER
MOUNTING
TEMPLATE
(Actual Size)
.100 MIN
OUTLINE OF COVER
DOTTED LINES CORRESPOND TO 4-1/2″
METER RELAY MOUNTING LOCATIONS

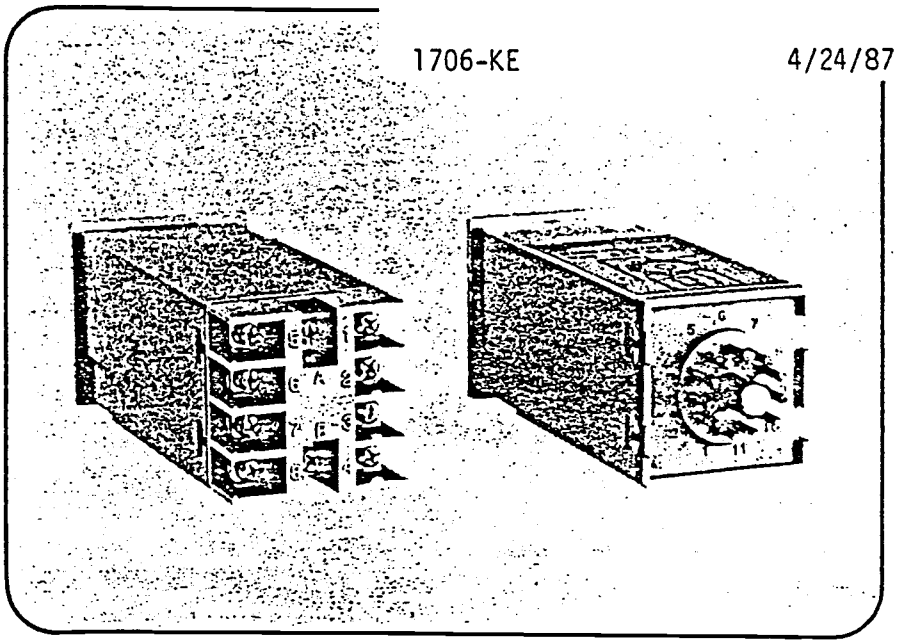
gulton

West Elf
Temperature Controllers



Main Features

- Compact 48 × 48mm to DIN 43700
- Low cost
- Panel mounting or plug-in base mounting
- Proportional + derivative (PD) or on/off control action
- LED relay state indication
- Rugged glass filled nylon case



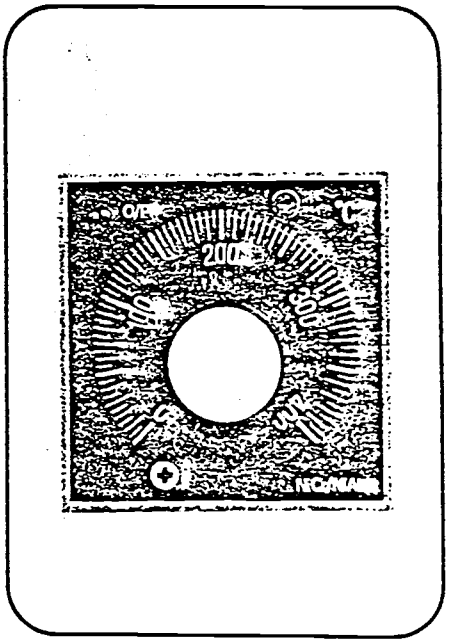
Specification

Reference Conditions

Ambient temperature	22°C±2°C, 71.5°F±3.5°F
Supply voltage	230V±1% or 115V±1%
Relative humidity	50±10% R.H.
Source resistance	<10Ω

Measuring

Minimum span	10mV
Maximum span	50mV
Scale length	90mm
Maximum T/C resistance	100Ω
Input impedance	>200 KΩ
Common mode	Negligible effect up to 250V 50/60 Hz
Series mode	30db rejection at 50/60Hz
Settling time	30 mins
Sensor break	Automatic protection
Cold junction	Automatic compensation



Control

Set point calibration accuracy	±2% of full scale
Proportional band	5%
Proportioning time	15 or 30 seconds nominal
Derivative time (Rate)	30 seconds
On/Off differential	0.4%

Output

Relay	SPDT rated 5A resistive at 240V A.C., 10^6 operations

Electrical

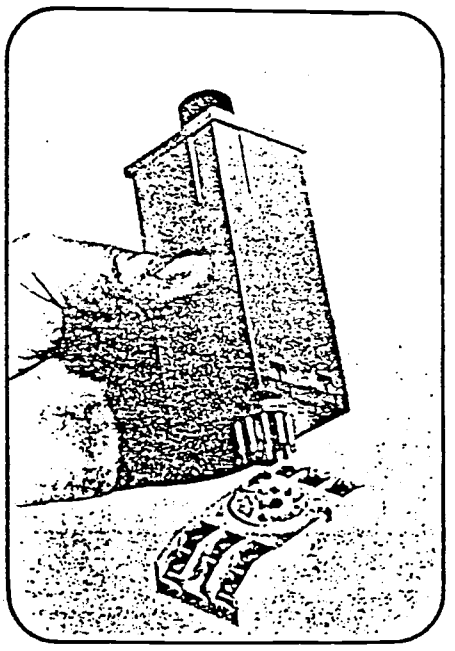
Power supply	193 - 255V, 50/60Hz or 97 - 127V, 50/60Hz
Power Consumption	<2VA

General

Ambient temperature working	0 - 50°C, 32 - 122°F
Ambient temperature storage	—10 to +70°C, 14 - 158°F
Weight	0.2kg approx.

Variance from reference conditions

Temperature influence on accuracy	5μV/°C, 2.8μV/°F
Voltage influence on accuracy	<0.25% (within supply tolerance)
Source resistance influence on accuracy	Negligible



Ordering Information

Model number is built up as follows:

ELF	BASIC NUMBER	CONTROL	PROPORTIONING TIME	RANGE AND THERMOCOUPLE TYPE	MAINS VOLTAGE

	Basic Number
Panel mounting case complete with mounting brackets	C10
11 pin base mounting case complete with base	C11

Control	Code
On/Off	100B
PD	103B

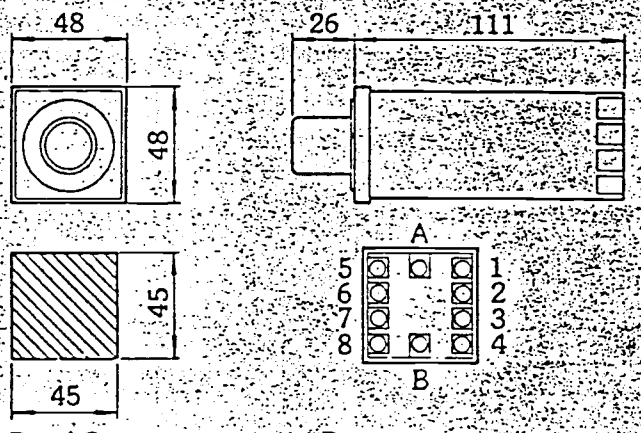
Proportioning Time	Code
15 seconds	15
30 seconds	30

Scale Ranges *Calibration to BS4937, NBS 125, IEC 584*

Iron/Constantan	Chromel/Alumel
0 - 200°C	0 - 250°C
0 - 400°C	0 - 400°C
0 - 600°C	0 - 600°C
0 - 400°F	0 - 1000°C
0 - 800°F	0 - 1200°C
0 - 1200°F	0 - 1600°F
	0 - 2500°F

Mounting & Wiring

Panel Mounting

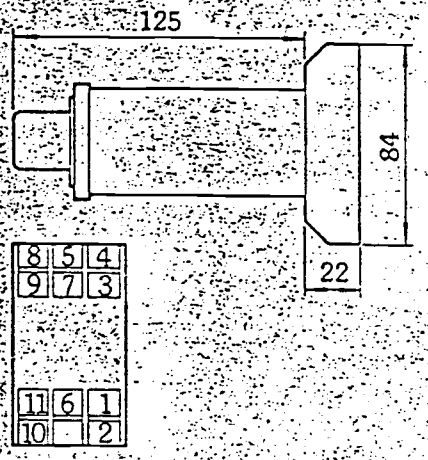


Panel Cutout Dimensions in millimetres

Terminal Configuration

A Line
B Neutral
1 Relay common
2 Relay closed contact
3 Relay open contact
4 —
5 —
6 —
7 Thermocouple +
8 Thermocouple —

Base Mounting



Terminal Configuration

1 Relay closed contact (relay coil de-energised)
2 Neutral
3 —
4 —
5 —
6 Relay common
7 Thermocouple —
8 Thermocouple +
9 —
10 Line
11 Relay open contact (relay coil de-energised)

WIRING

Local codes of practice regarding electrical installation should be rigidly observed, particularly regarding the provision of isolators. The access doors of the enclosure in which the instrument is fitted should be provided with interlocks such that the electrical supply to the enclosure is disconnected when the doors are opened.

POWER SUPPLY

The instrument is suitable for a power supply of between 193V and 255V, or between 97V and 127V 50/60Hz.

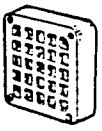
It is recommended that the power supply to each instrument includes a 1 amp fuse and a double pole switch.

FEDERAL VIBRATONE HORNS

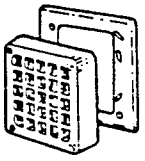
Are excellent for code signals, general alarms, or time indications. Size, appearance, volume adjustment, and installation options make these horns ideal. Modular design adapts one unit to any application.

Available in standard AC or DC from 6 to 250, 25 or 60 hertz. Models 350 and 450 are the basic units, suitable for mounting on panels, in cabinets or in 4" square outlet boxes.

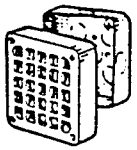
Model 350 produces 100 dB at 10 feet and Model 450 produces 97 dB at 10 feet.



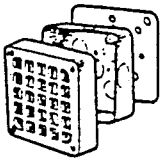
350



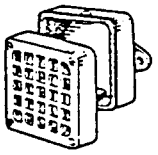
350SF



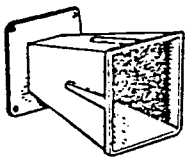
350NB



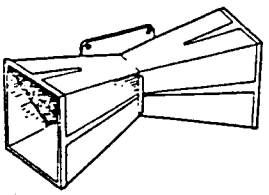
350CC



350WB



PR
Single Projector

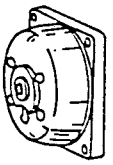


PR2
Double Projector

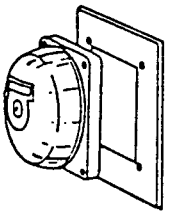
No.	Description	Each
350	Basic AC Horn	$59.16
450	Basic DC Horn	94.50
NB	4" Interior Type Knockout Box	4.56
WB	Gasketed-Cast Weatherproof Box	17.50
SF	Semi-Flush Wall Plate	7.00
CC	Concealed Conduit Adapter Plate	7.00
FG	Grille For Flush Mounting	6.30
FB	Wallbox For Flush Mounting	24.16
FBL	Deep Box For Flush Mounting	27.66
PR	Projector Only	12.96
PR2	Double Projector	29.40

FEDERAL VIBRATONE BELLS

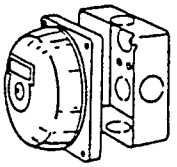
Modular design of our bells makes use of one basic mechanism with option of 4, 6 or 10" gongs for a wide variety of mountings. Mounts on standard outlet boxes. Heavy duty but low current consumption available for AC or DC, single stroke as well as standard vibrating type. Decibel ratings at 10 feet are: 4" bell, 98 dB, 6" bell, 100 dB, 10" bell, 102 dB. Chimes are available for AC or CD on same voltages as bells. Decibel rating at 10 feet is 75 dB.



Basic Mechanism
#500 or 700 for AC
600 or 800 for DC



SF



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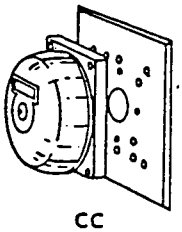

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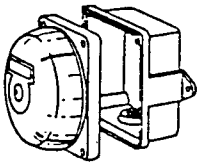
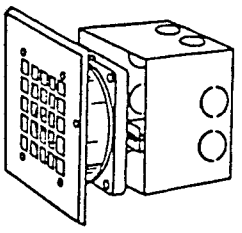


WB



FBL

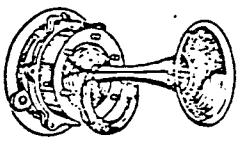
Standard AC Voltages:
6-12-24-120-240

Standard DC Voltages:
6-12-48-125-250

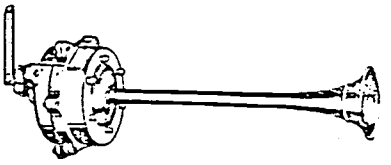
No.	Description	Each
500	AC Vibratory	$65.46
600	DC Vibratory	87.16
700	AC Single Stroke	65.46
800	DC Single Stroke	65.46
A4	4" Gong Assembly	16.10
A6	6 Gong Assembly	37.10
A10	10" Gong Assembly	56.70
SF	Semi-Flush Mt.	7.00
CC	Concealed Conduit	7.00
FG	Flush Grille – 4" Bells	6.30
FG6	Flush Grille – 6 Bells	27.30
NB	4" Interior K.O. Box	4.56
WB	4 Weatherproof Box	17.50
FBL	Flush Box – 4" Bells	27.66
FB6	Flush Box – 6 Bells	47.56
PR	Projector – 4" Bells	12.96
PR2	Dbl. Proj. – 4" Bells	29.40
G6	Gong Guard – 6" Bells	46.56
G10	Gong Guard – 10" Bells	55.66

FEDERAL RESONATING ELECTRIC HORNS

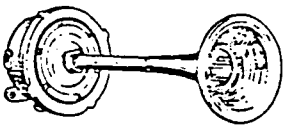
Loud Trumpet Tone Blast



Model 53. Interior type horns, non-weatherproof, have plug-in feature to simplify mounting. The back plate attaches to any standard knockout box and the horn in turn attaches to the back plate with three nuts. The coiled projector, standard on this model provides greater clearance in congested mounting locations. The interior models are finished in red.



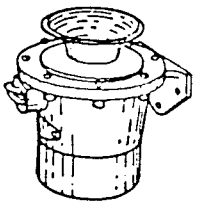
Model 55. Weatherproof and also watertight and dustright when attached to conduit. Weatherproof models are recommended as preferable, even for interior use, to reduce maintenance as they seal out corrosive dusts and vapors, so often present in industrial environments. Finished in gray hammertone enamel. The swivel bracket and straight projectors are standard construction.



Model 55X. Explosion-proof models specially constructed for use in hazardous locations. Meets all specifications of the Underwriters' Laboratories for use in Class I, Groups C and D and Class II, Groups E, F and G locations.

No.	Voltage	Each
53	24 to 240	$289.46
55	24 to 240	322.70
55X	24 to 240	941.16

FEDERAL MOTOR-DRIVEN HORN



The advantages of motor driven horns are primarily that they have a powerful tone, second only to that of resonating horns. The tone is harsh and varies slightly in frequency as the motor starts and stops. They serve best as general alarm signals when a distinctive tone is needed to contrast with other horns in an existing system used for another purpose. Weatherproof and water-tight.

No.	Volts	Each
20	120-240V AC/DC	$496.30

Not Ave

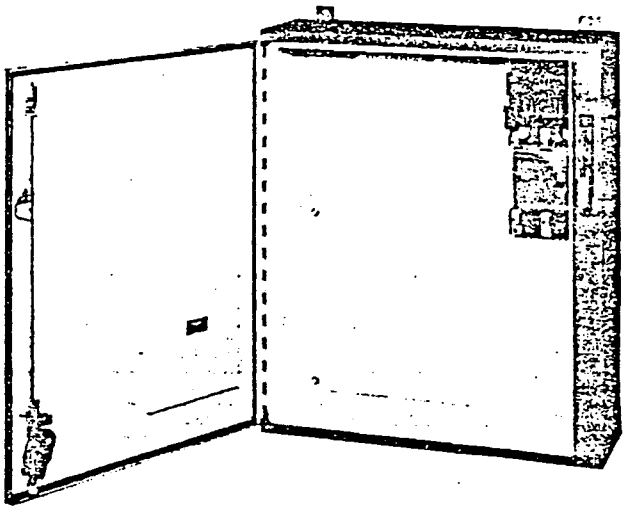
D-144

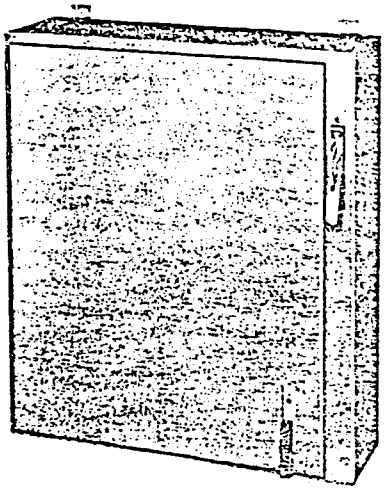
Hoffman®
BULLETIN A-22
MARCH 1979

SINGLE DOOR NEMA TYPE 12 ENCLOSURES FOR ALLEN-BRADLEY DISCONNECTS

(FOR BULLETIN 1494F AND BULLETIN 1494D DEVICES ONLY)

A-22





APPLICATION — Hoffman Single Door NEMA Type 12 Enclosures for Allen-Bradley Disconnects are designed to house Allen-Bradley Bulletin 1494F flange mounted disconnect switches and Bulletin 1494D flange mounted operators for circuit breakers. (See Bulletins A-25 and A-25.1 for single door enclosures which receive Allen-Bradley Bulletin 1494V disconnect devices.) They have the same oil-tight and dust-tight features found in standard Hoffman NEMA 12's.

CONSTRUCTION — These enclosures are made from 14 gauge steel and have a strong and rigid construction. All seams are continuously welded. A rolled lip is provided around all sides of the enclosure opening; this increases strength and keeps dirt and liquids from dropping into the enclosure when the door is opened. The neoprene door gasket is attached with oil-resistant adhesive, and is also held in place with steel retaining strips. The door can be removed by pulling the hinge pin. Each enclosure has a removable print pocket. Only two small weldpins show on the inside of the door if the print pocket is removed. Body stiffeners and door stiffeners are provided in large enclosures for extra rigidity. External feet are furnished for mounting. Collar studs are provided for mounting the optional panels. PANELS MUST BE ORDERED SEPARATELY.

The enclosures are furnished with the necessary holes in the body and door for mounting the disconnect switch, operating mechanism, and door hardware. Guide brackets and a door catch are welded to the inside of the door, and locking bars are provided. Spacers and screws are provided to secure the disconnect switch and fuse block adapter plate to the panel. Instructions for installing disconnect switches and operating mechanisms are furnished with each enclosure. THE DISCONNECT SWITCH AND OPERATING MECHANISM ARE NOT FURNISHED WITH THE ENCLOSURE.

Enclosures with an "A" dimension under 40 inches require 2-point door hardware (one Allen-Bradley Catalog No. 1494F-L1). Enclosures with an "A" dimension of 40 inches or more require 3-point door hardware (one Allen-Bradley Catalog No. 1494F-L2 and one Catalog No. 1494F-L3 for 8 inch and 10 inch deep enclosures; one Catalog No. 1494F-L4 for 10¼ inch deep enclosures). DOOR HARDWARE IS NOT FURNISHED WITH THE ENCLOSURE.

ACCESSORIES —

PANELS — Panels must be ordered separately, as they are not furnished with the enclosures. Panels are 12 gauge steel.

FLOOR STAND KITS — Floor stand kits in 6-inch, 12-inch, 18-inch, and 24-inch heights are available for factory or field installation on these enclosures. See the following page for details.

MISC. ACCESSORIES — Other accessories include oil-tight hole seals, touch-up paint, gasketed hubs, louver plate kits, window kits, and panel support kits. See Bulletin A-80 for details.

FINISH — The standard finish is white enamel inside and gray prime outside over phosphatized surfaces. Panels are white enamel.

FACTORY INSTALLATION OF DISCONNECTS — For those customers who prefer not to install the disconnect themselves, Hoffman can furnish and install disconnect switches and operating mechanisms, fuse block adapter plate kits, and door hardware; or Hoffman can install customer-furnished components. See price sheet for installation charges for customer furnished components. Consult the factory for installation charges for Hoffman-furnished components. Specify (1) catalog number of Hoffman enclosure, (2) catalog number of Allen-Bradley disconnect switch, (3) amperage rating, voltage, and class (H or J) of fuse clip, if switch is fusible.

MODIFICATIONS — Hoffman can supply holes, hubs, louvers, cutouts, special finishes, special materials, special enclosure sizes and many other modifications. Consult the factory for prices. Be sure to specify (1) enclosure dimensions, (2) catalog number of Allen-Bradley disconnect switch, (3) amperage rating, voltage, and class (H or J) of fuse clip, if switch is fusible, (4) other enclosure construction details. Advise if components (1) will be installed by the customer, (2) will be furnished by the customer for factory installation, (3) will be furnished and installed by Hoffman.

INDUSTRY STANDARDS — These enclosures conform to the National Electrical Manufacturers Association (NEMA) standard for Type 12 (Industrial-use) enclosures. They also conform to Joint Industrial Council (JIC) standard EGP-1-1967. Many of these enclosures are listed by Underwriters' Laboratories, Inc. as indicated in the table on the following page.

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SINGLE DOOR ENCLOSURES

The enclosures listed in this bulletin will receive the disconnects listed below. Wire space will be equal to or greater than the wire space recommended by the disconnect manufacturer. If you require greater wire space or have a special situation, check the dimensions carefully to assure that you have the clearances you desire.

The 8 inch deep enclosures will receive the following disconnects:

a. 30A and 60A Bulletin 1494F flange mounted disconnect switches.
b. Bulletin 1494D flange mounted operators for ITE (E, EF, and EH) circuit breakers with amperage ratings from 15A to 70A.
c. Bulletin 1494D flange mounted operators for Westinghouse EB, EHB, and FB circuit breakers with amperage ratings from 15A to 70A.

The 10 inch deep enclosures will receive all of the above disconnects, plus the following:

a. 100A Bulletin 1494F flange mounted disconnect switches.
b. Bulletin 1494D flange mounted operators for ITE (E, EF, and EH) circuit breakers with amperage ratings from 90A to 100A, and for ITE FJ circuit breakers.
c. Bulletin 1494D flange mounted operators for Westinghouse EB and EHB circuit breakers with amperage ratings from 90A to 100A, FB circuit breakers with amperage ratings from 90A to 150A, and for Westinghouse JA, KA, LB, LBB, HLB circuit breakers.

The 10¼ inch deep enclosures will receive ONLY the 200A Bulletin 1494F flange mounted disconnect switches.

Enclosures to receive other Allen-Bradley disconnects can be made on special order. Consult the factory for prices.

See Bulletins A-25 and A-25.1 for enclosures which receive Allen-Bradley Bulletin 1494V disconnect devices.

STANDARD SIZES

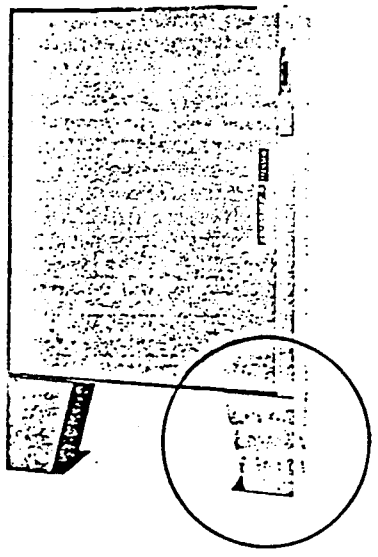
Enclosure Catalog Number	Enclosure Size A x B x C	*Panel Catalog Number	Panel Size
• A-20AB2108LP	20 x 21 3/8 x 8	A-20P20	17 x 17
• A-24AB2108LP	24 x 21 3/8 x 8	A-24P20	21 x 17
• A-24AB2508LP	24 x 25 3/8 x 8	A-24P24	21 x 21
• A-30AB2108LP	30 x 21 3/8 x 8	A-30P20	27 x 17
• A-30AB2508LP	30 x 25 3/8 x 8	A-30P24	27 x 21
• A-36AB2508LP	36 x 25 3/8 x 8	A-36P24	33 x 21
A-36AB3108LP	36 x 31 3/8 x 8	A-36P30	33 x 27
A-42AB3108LP	42 x 31 3/8 x 8	A-42P30	39 x 27
A-42AB3708LP	42 x 37 3/8 x 8	A-42P36	39 x 33
A-48AB3708LP	48 x 37 3/8 x 8	A-48P36	45 x 33
A-60AB3708LP	60 x 37 3/8 x 8	A-60P36	57 x 33
• A-24AB2110LP	24 x 21 3/8 x 10	A-24P20	21 x 17
• A-24AB2510LP	24 x 25 3/8 x 10	A-24P24	21 x 21
• A-30AB2110LP	30 x 21 3/8 x 10	A-30P20	27 x 17
• A-30AB2510LP	30 x 25 3/8 x 10	A-30P24	27 x 21
• A-36AB2510LP	36 x 25 3/8 x 10	A-36P24	33 x 21
A-36AB3110LP	36 x 31 3/8 x 10	A-36P30	33 x 27
A-42AB3110LP	42 x 31 3/8 x 10	A-42P30	39 x 27
A-42AB3710LP	42 x 37 3/8 x 10	A-42P36	39 x 33
A-48AB3710LP	48 x 37 3/8 x 10	A-48P36	45 x 33
A-60AB3710LP	60 x 37 3/8 x 10	A-60P36	57 x 33
A-48AB37200LP	48 x 37 1/2 x 10 1/4	A-48P36	45 x 33
A-60AB37200LP	60 x 37 1/2 x 10 1/4	A-60P36	57 x 33

*Panels must be ordered separately.
•U.L. LISTED

When ordering flange mounted disconnects from Allen-Bradley, be sure to order the necessary items. When using a Bulletin 1494F flange mounted disconnect switch, order (1) a disconnect switch, (2) a fuse block adapter (if required), (3) line and load connectors (if required), and (4) a door hardware kit (2-point or 3-point as explained on the preceding page). When using a Bulletin 1494D flange mounted operator for a circuit breaker, order (1) a circuit breaker (ITE or Westinghouse), (2) a flange mounted operator mechanism, (3) a slide mechanism, (4) a door hardware kit (2-point or 3-point as explained on the preceding page).

This information is subject to change; please contact Hoffman or Allen-Bradley if there are questions.

SINGLE DOOR FLOOR STAND KITS



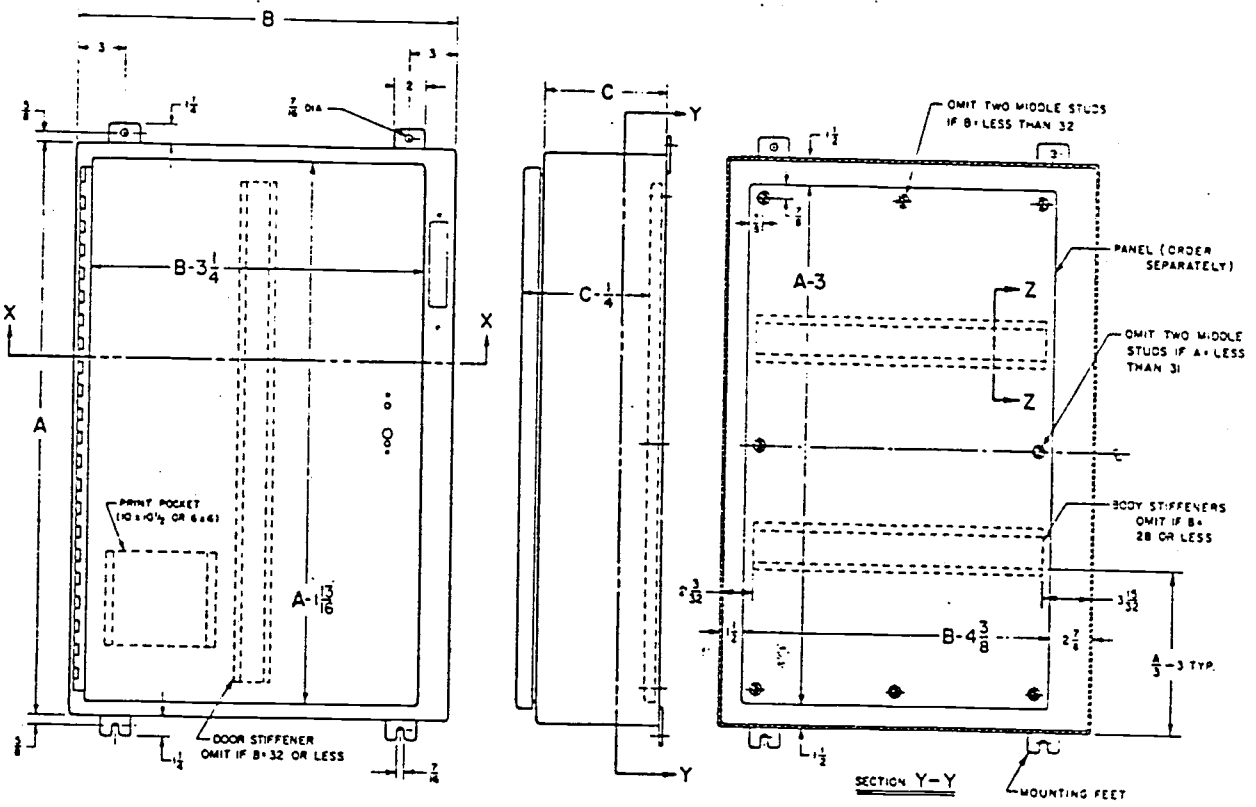
Any single door wall-mounted enclosure can be converted to a floor-mounted unit by the addition of a floor stand kit. The floor stand kit can be quick, installed in the field or at the factory.

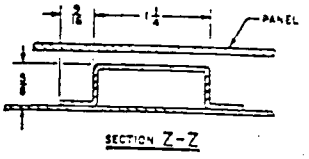
Floor Stand Kit Catalog Number	Description
A-FK0608	6" high floor stand for 8" deep enclosures
A-FK1208	12" high floor stand for 8" deep enclosures
A-FK1808	18" high floor stand for 8" deep enclosures
A-FK2408	24" high floor stand for 8" deep enclosures
A-FK0610	6" high floor stand for 10" or 10¼" deep enclosures
A-FK1210	12" high floor stand for 10" or 10¼" deep enclosures
A-FK1810	18" high floor stand for 10" or 10¼" deep enclosures
A-FK2410	24" high floor stand for 10" or 10¼" deep enclosures

NEMA TYPE 12 ENCLOSURES FOR ALLEN-BRADLEY DISCONNECTS

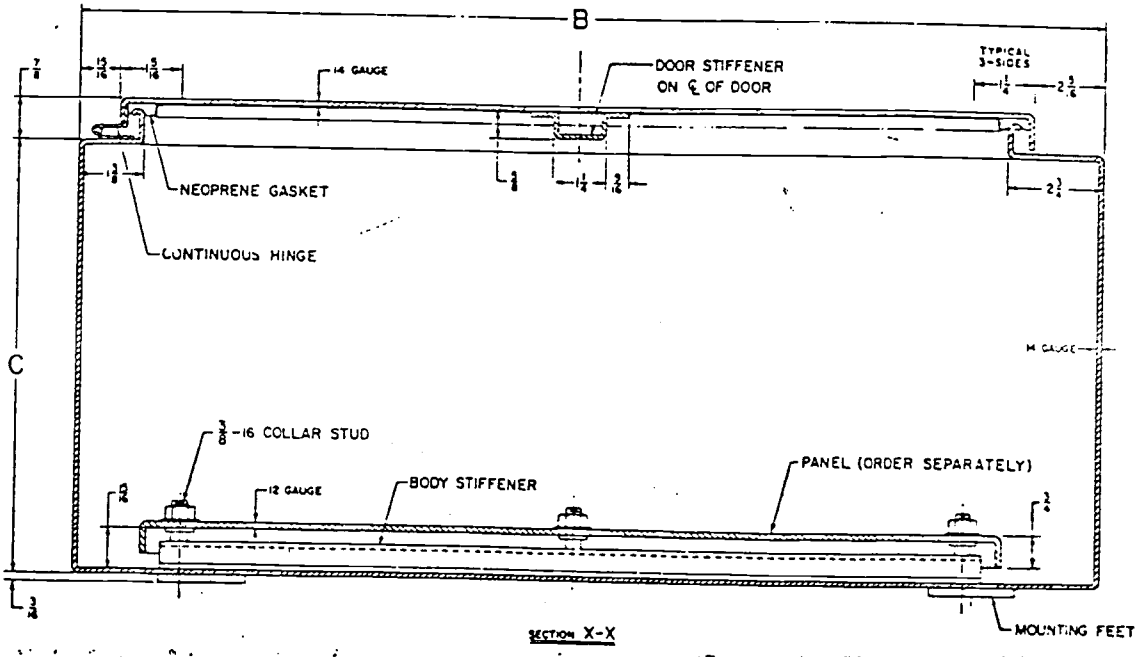
BULLETIN A-22

NOTE: The drawings below do not apply to Catalog Numbers A-48AB37200LP or A-60AB37200LP. Please consult factory for dimensions of these two models.





NOTE:
1. Large print pocket furnished if A=30 or more and B=20 or more.
2. Panels have flanges along sides which are more than 17 inches long.



SPACE OCCUPIED BY ALLEN-BRADLEY DISCONNECTS IN SINGLE DOOR ENCLOSURES

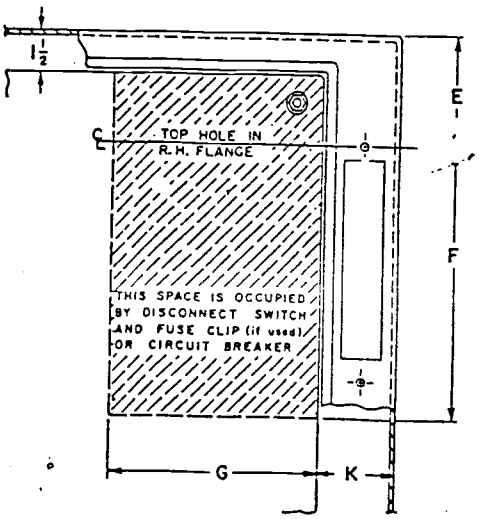
ALLEN-BRADLEY 1494F DISCONNECT SWITCHES

Switch Amp Rating	Fuse Clip	Class	F	G**
30A	No Fuse	----	4 5/8	6
30A	30A - 250V	H	6½	5
30A	60A - 250V	H	7¼	6
30A	30A - 600V	H	9¼	6
30A	60A - 600V	H	9¾	6
30A	30A - 600V	J	6½	6
30A	60A - 600V	J	6 5/8	6
60A	No Fuse	----	4 5/8	6
60A	30A - 600V	H	10 3/8	6
60A	60A - 250V	H	8 3/8	6
60A	100A - 250V	H	10 7/8	6
60A	60A - 600V	H	10 7/8	6
60A	100A - 600V	H	12 7/8	6
60A	60A - 600V	J	7¾	6 1/8
60A	100A - 600V	J	9¾	6
*100A	No Fuse	----	4 5/8	6¾
*100A	100A - 250V	H	11 3/8	6¾
*100A	200A - 250V	H	12¼	7
*100A	100A - 600V	H	13 3/8	6 7/8
*100A	200A - 600V	H	14¾	7 1/8
*100A	100A - 600V	J	10 1/8	6¾
*100A	200A - 600V	J	10 7/8	7
***200A	No Fuse	----	7 1/8	9¾
***200A	200A - 250V	H	15	9¾
***200A	400A - 250V	H	16½	10 1/8
***200A	200A - 600V	H	17½	9¾
***200A	400A - 600V	H	19½	10 3/8
***200A	200A - 600V	J	13 3/8	9¾
***200A	400A - 600V	J	15	10

ALLEN-BRADLEY 1494D CIRCUIT BREAKERS

Frame Rating	Breaker Type	Frame Size	Max. Amp Rating	F	G
100A	ITE	E, EF, EH	70	6½	5 1/8
*100A	ITE	E, EF, EH	150	6½	5 1/8
100A	WESTINGHOUSE	EB, EHB, FB	70	6½	4 7/8
*100A	WESTINGHOUSE	EB, EHB, FB	150	6½	4 7/8
*225A	ITE	FJ	225	9½	4½
*225A	WESTINGHOUSE	JA, KA	225	9½	5½
*400A	WESTINGHOUSE	LB, LBB, HLB	400	9½	5½

NOTE:
*These switches can be installed in 10 inch deep enclosures only.
**The G dimension does not include space for auxiliary switches. See A-B instructions for additional space required.
***These switches can be installed in 10¼ inch deep enclosures only.



NOTE: E = 3 7/32 when C = 8
E = 6¾ when C = 10
E = 8 1/16 when C = 10¼

K = 2 7/8 when C = 8
K = 2 7/8 when C = 10
K = 3 when C = 10¼

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200-LINE FULL VOLTAGE NON-REVERSING MAGNETIC MOTOR STARTERS

1600 Hp Max. NEMA Sizes 00-9 600 Volts Max. 60 Hertz

D-5, D-5H, D-5K, D-5L①

PRICING INFORMATION—Three-pole Forms, Three-leg Protection, 60 Hertz

List price includes a holding interlock. Three heaters should be specified and ordered as a separate item at **$6.00 each, GO-10G**. Select heaters by using tables on pages 493-496.

NEMA Size	Enclosed Continuous Amp Rating	Max. Horsepower② Motor Voltage	Max. Horsepower② Horsepower	Starter Coil Voltage (60 Hz)③	NEMA Type 1 General Purpose Catalog Number CR206	NEMA Type 1 General Purpose List Price, GO-10G	NEMA Type 4 Watertight, Dust-tight (Stainless Steel) Catalog Number CR206	NEMA Type 4 List Price, GO-10G	NEMA Type 4X Watertight, Dust-tight, Corrosion-resistant Catalog Number CR206	NEMA Type 4X List Price, GO-10G	NEMA Type 12⑨ Dust-tight, Driptight Industrial Use Catalog Number CR206	NEMA Type 12⑨ List Price, GO-10G
00	9	Separate Control—115 Volts			A102	$116	Use NEMA Size 0		—	—	Use NEMA Size 0	
		200-208	1½	200/208	A123				—	—		
		220-240	1½	230	A103				—	—		
		440-480	2	460	A104				—	—		
		550-600	2	575	A105				—	—		
0	18	Separate Control—115 Volts			B102	144	B402	$284	B402SAA	$306	B202	$192
		200-208	3	200/208	B123		B423		B423SAA		B223	
		220-240	3	230	B103⑧		B403		B403SAA		B203	
		440-480	5	460	B104		B404		B404SAA		B204	
		550-600	5	575	B105		B405		B405SAA		B205	
1	27	Separate Control—115 Volts			C102	164	C402	308	C402SAA	330	C202	212
		200-208	7½	200/208	C123		C423		C423SAA		C223	
		220-240	7½	230	C103⑧		C403		C403SAA		C203	
		440-480	10	460	C104		C404		C404SAA		C204	
		550-600	10	575	C105		C405		C405SAA		C205	
2	45	Separate Control—115 Volts			D102	324	D402	612	D402SAA	660	D202	412
		200-208	10	200/208	D123		D423		D423SAA		D223	
		220-240	15	230	D103		D403		D403SAA		D203	
		440-480	25	460	D104		D404		D404SAA		D204	
		550-600	25	575	D105		D405		D405SAA		D205	
3	90	Separate Control—115 Volts			E102	540	E402	948	Refer to nearest GE sales office		E202	644
		200-208	25	200/208	E123		E423				E223	
		220-240	30	230	E103		E403				E203	
		440-480	50	460	E104		E404				E204	
		550-600	50	575	E105		E405				E205	
4	135	Separate Control—115 Volts			F102	1220	F402	1916	Refer to nearest GE sales office		F202	1564
		200-208	40	200/208	F123		F423				F223	
		220-240	50	230	F103		F403				F203	
		440-480	100	460	F104		F404				F204	
		550-600	100	575	F105		F405				F205	
5	270	Separate Control—115 Volts			G102	2878	G402	3758	Refer to nearest GE sales office		G202	3758
		200-208	75	200/208	G123		G423				G223	
		220-240	100	230	G103		G403				G203	
		440-480	200	460	G104		G404				G204	
		550-600	200	575	G105		G405				G205	
				Control Circuit Voltage②	Catalog Number CR286						Catalog Number CR286	
6⑦	540	Separate Control—115 Volts			H102AA1A	$8110	—	—	—	—	H202AA1A	$9190
		200-208	150	200/208	H123AA1A		—	—	—	—	H223AA1A	
		220-240	200	230	H103AA1A		—	—	—	—	H203AA1A	
		440-480	400	460	H104AA1A		—	—	—	—	H204AA1A	
		550-600	400	575	H105AA1A		—	—	—	—	H205AA1A	
7⑦	810	Separate Control—115 Volts			J102AA1A	10778	—	—	—	—	J202AA1A	11858
		220-240	300	230	J103AA1A		—	—	—	—	J203AA1A	
		440-480	600	460	J104AA1A		—	—	—	—	J204AA1A	
		550-600	600	575	J105AA1A		—	—	—	—	J205AA1A	
8⑦	1215	Separate Control—115 Volts			K102AA1A	14970	—	—	—	—	K202AA1A	16050
		220-240	450	230	K103AA1A		—	—	—	—	K203AA1A	
		440-480	900	460	K104AA1A		—	—	—	—	K204AA1A	
		550-600	900	575	K105AA1A		—	—	—	—	K205AA1A	
9⑦	2250	Separate Control—115 Volts			L102AA1A	23322	—	—	—	—	L202AA1A	24402
		220-240	800	230	L103AA1A		—	—	—	—	L203AA1A	
		440-480	1600	460	L104AA1A		—	—	—	—	L204AA1A	
		550-600	1600	575	L105AA1A		—	—	—	—	L205AA1A	

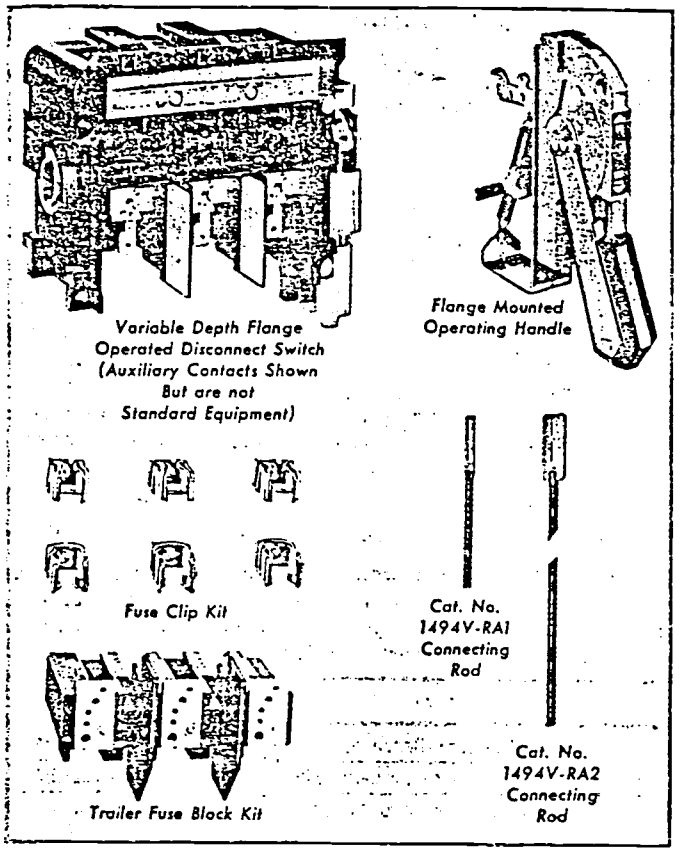
① Enclosed starters.
② Motor full-load current should not exceed continuous ampere rating of enclosed starter.
③ Refer to coil table, page 105, and to ordering directions, page 12, for NEMA Sizes 00-5 starters with other coil ratings. For NEMA Sizes 6-9 starters with other control-circuit voltages, refer to nearest GE sales office or local franchised distributor.
④ External reset not included on standard listed forms.
⑤ Units are individually boxed and "Poly-Packed" six per carton as standard.
⑥ Size 6 and 7 forms shown are wall-mounted type. They are also available in floor-mounted type; for complete information contact your nearest GE sales office or local franchised distributor.
⑦ Floor-mounted type.

REFERENCES:
See page 13

Prices and data subject to change without notice

VARIABLE DEPTH FLANGE OPERATED DISCONNECT SWITCHES

BULLETIN 1494V



DESCRIPTION — Bulletin 1494V variable depth flange operated visible blade disconnect switches and circuit breakers with Allen-Bradley operating mechanisms meet industrial requirements for dependable manually operated disconnecting means. Disconnect switch load terminations are designed to accept lugs, for non-fused installations, or fuse clips. Trailer fuse blocks and clips are available for most fuse types and sizes. Operating handles and disconnecting means are adaptable to NEMA Type 1, 3R, 3 or Type 12 enclosures with right or left hand flange construction. When used in conjunction with door hardware kits, the complete assembly meets the requirements of most industry specifications.

DISCONNECT SWITCHES — These are heavy duty horsepower rated devices.

NEMA Size	Max. Horsepower Rating									Catalog Number	Price
	3 Phase AC					Single Phase AC		DC			
	115	200-208	230	460	575	115	230	115	230		
30	3	7½	7½	15	20	2	3	3	5	1494V-DS30	$46
60	7½	15	15	30	50	3	10	5	10	1494V-DS60	50
100	—	25	30	60	75	—	—	—	20	1494V-DS100	70

OPERATING HANDLE — The operating handle listed below is for use with all Bulletin 1494V disconnect switches and circuit breaker mechanisms.

Catalog Number 1494V-H1.....List Price...$15.00

CONNECTING RODS — The connecting rods listed below are for use with the operating handle. Specify the rod based on depth of enclosure. Enclosure depth is measured from the top of the flange to the disconnecting means mounting surface.

Enclosure Depth		Catalog Number	Price
Minimum	Maximum		
6¾ Inches	9⅛ Inches	1494V-RA1	$5.00
9⅛ Inches	21⅛ Inches	1494V-RA2	7.00

TRAILER FUSE BLOCK KITS — The trailer fuse block kits listed below, when combined with a properly sized disconnect switch and fuse clip kit (Class H and J fuses), provide a complete functional assembly. (For Class H and J fuses, select the proper fuse clips from the fuse clip chart.) For Class R fuse applications, non-removable rejection type clips are mounted on the trailer fuse block at the factory. Three additional clips are included for mounting on the disconnect switch.

Disconnect Size	Class H & J			Class R			
	Fuse Size	Catalog No.	Price	Fuse Size 250V	Fuse Size 600V	Catalog No.	Price
30A	1-30	1494V-FS30	$4	30	—	1494V-FSR233	$9
	31-60	1494V-FS63	4	—	30	1494V-FSR633	13
60A	31-60	1494V-FS60	4	60	—	1494V-FSR266	13
	61-100	1494V-FS16	11	—	60	1494V-FSR666	17
100A	61-100	1494V-FS100	11	100	100	1494V-FSR611	38
	101-200	1494V-FS21	26				

FUSE CLIP KITS — Includes six clips and mounting hardware.

Fuse Class	Fuse Clip Rating (Amps)		Catalog Number	Price
	250 Volts	600 Volts		
H	30	—	1401-N41	$2
H, J	60	30	1401-N42	6
H, J	—	60	1401-N43	10
H, J	100	100	1401-N44	21
H, J	200	200	1401-N45	38

PRESSURE TYPE CONNECTORS — All terminals of the 30 amp disconnect switch come with wiring clamps for #14 through #8 wire. The following copper alloy pressure lugs are recommended for use on the 60 and 100 amp switches. All lugs fit on the line and load terminals of the disconnects, as well as on the terminals of the trailer fuse blocks.

60 amp lugs for #14 through #4 wire.....
Cat. No. 1494R-N1 (Set of 3).....$2.00

100 amp lugs for #8 through #1/0 wire.....
Cat. No. 1494R-N2 (Set of 3).....$5.00

DISCONNECT SWITCH KITS — Refer to Page 276.

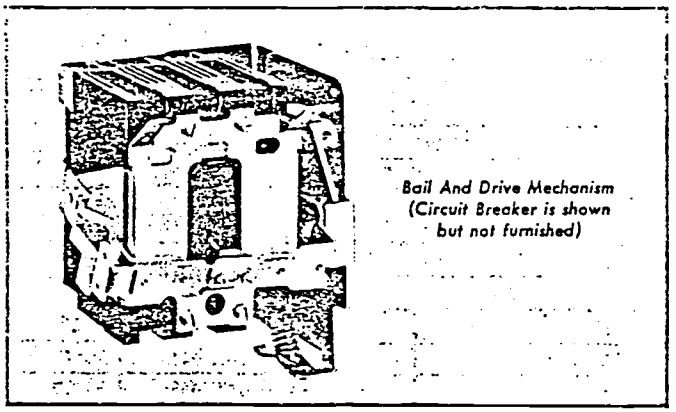
ORDERING INFORMATION — The required devices for a complete installation are an operating handle, a connecting rod, a disconnecting device (either a disconnect switch or a circuit breaker with an operating mechanism), a trailer fuse block kit and a fuse clip kit (for installations requiring fusing), and a door hardware kit (for NEMA Type 12 applications). These items may be ordered separately or in kit form. Other accessories shown on Page 276 are also available and should be specified when required.

BULLETIN 1494V VARIABLE DEPTH FLANGE OPERATED DISCONNECT SWITCHES

DISCONNECT SWITCH KITS — Non-fusible kits include a disconnect switch, operating handle and Catalog Number 1494V-RA1 connecting rod. Fusible kits also include a trailer fuse block and fuse clips. Door hardware for NEMA Type 12 enclosures must be ordered separately.

Disconnect Size	Type	Fuse Size	Class H & J Dimension			
			250 Volts		600 Volts	
			Catalog No.	Price	Catalog No.	Price
30A	Non-Fusible	—	—	—	1494V-DN30	$66
	Fusible	1-30A	1494V-DH233	$72	1494V-DH633	76
60A	Non-Fusible	—	—	—	1494V-DN60	70
	Fusible	31-60A	1494V-DH266	80	1494V-DH666	84
100A	Non-Fusible	—	—	—	1494V-DN100	90
	Fusible	61-100A	1494V-DH611	122	1494V-DH611	122

Kits with Class R fuse clips are also available. To order, substitute the letter "R" for the letter "H" in the listed catalog number. List price addition is $3 for 30A and 60A kits, and $6 for 100A kits.



Bail And Drive Mechanism (Circuit Breaker is shown but not furnished)

CIRCUIT BREAKER OPERATING MECHANISMS — The bail and drive mechanisms listed below must be combined with a connecting rod, operating handle and circuit breaker (not included) to obtain a functional device.

Circuit Breaker		Bail Mechanism		Drive Mechanism	
Make	Frame	Cat. No.	Price	Cat. No.	Price
ITE	E, EF, EH	1494V-M10	$6	1494V-M1	$10.00

DOOR HARDWARE — The door hardware kits listed below are designed to function with all Bulletin 1494V disconnect switches and circuit breaker mechanisms. The kits are designed for use in small (up to 40 inch), intermediate (40 to 60 inch) or large (over 60 inch) NEMA Type 12 enclosures. They provide for enclosure sealing and guard against unauthorized entry.

Selection Recommendation — Use Catalog Number 1494V-L1 or LL1 for small enclosures, Catalog Number 1494V-L2 with 1494V-L1 or LL1 for intermediate enclosures, and use Catalog Number 1494V-L3 or LL3 for large enclosures.

Latching Arrangement	Handle Length	Catalog Number		Price
		Right Hand	Left Hand	
Top & Side	4½"	1494V-L1	1494V-LL1	$32
Bottom Only	—	1494V-L2	1494V-L2	7
Top, Bottom & Side	6"	1494V-L3	1494V-LL3	41

MISCELLANEOUS ACCESSORIES

Alternate Mounting Kits — For use where the flange material thickness is greater than 3/16".

Alternate Mounting Kits.....Cat. No. 1494V-H3.....$2.00

Channel Support Kits — For use to prevent flexing of the operating handle mounting surface. This is especially useful when the operating handle is mounted on a channel in a multi-door enclosure.

Channel Support Kit.....Cat. No. 1494V-H4.....$6.00

Multiple Door Interlock Kits — Designed to be used with the Catalog Numbers 1494V-L3 and 1494V-LL3 hardware kits. They provide interlocking between the master door and auxiliary doors of the same enclosure. Specify one master door kit and as many auxiliary door kits, (up to 9) as necessary. Connecting bars must be supplied by the user.

Master Interlock Kit.....Cat. No. 1494F-N20.....$35.00

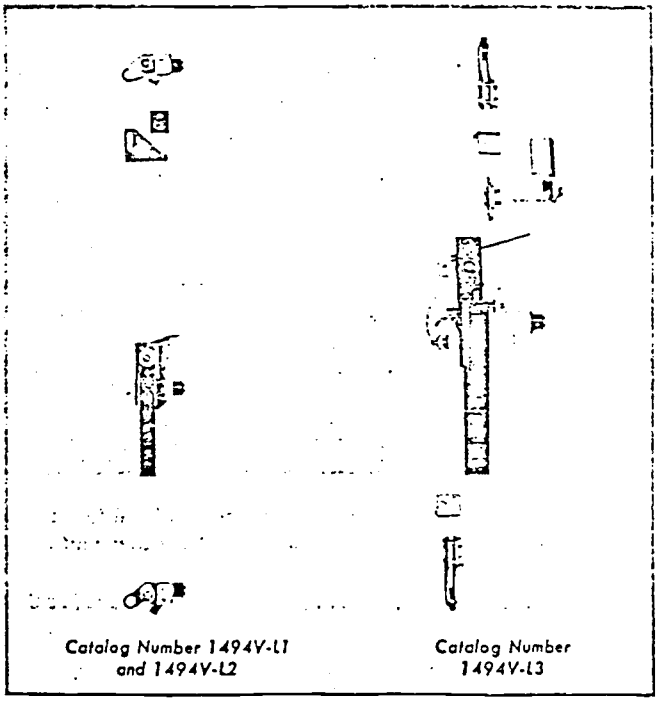
Auxiliary Interlock Kit.....Cat. No. 1494F-N21.....$40.00

Auxiliary Contacts — Disconnect switches and circuit breaker mechanisms are designed to accept up to 2 N.O. or N.C. auxiliary contacts. Circuit breaker mechanisms also require the use of an auxiliary contact adapter kit.

Description	Catalog Number	Price
N.O. Auxiliary Contact for Disconnect Switch	595-A	$12.00
N.C. Auxiliary Contact for Disconnect Switch	595-B	12.00
Auxiliary Contact Adapter Kit for Circuit Breaker Mechanism	1495-N17	8.00
N.O. Auxiliary Contact for Circuit Breaker	1495-N8	12.00
N.C. Auxiliary Contact for Circuit Breaker	1495-N9	12.00

Energy Limiter Adapter Plate Kit — For use with ITE 100A frame size circuit breakers.

Catalog No. 1494V-H10.....$8.00



Catalog Number 1494V-L1 and 1494V-L2 *Catalog Number 1494V-L3*

Another
BUSS QUALITY
Fuse

BUSS® ONE-TIME FUSES

BUSS One-Time fuses are available in standard N.E.C. sizes through 600 amperes for 250 volt and 600 volt applications. Special sizes are available above 600 amperes up to 1000 amperes; however, their dimensions are not standard.

Operating Characteristics

One-Time fuses, 1 ampere through 600 amperes are Underwriters' Laboratories tested to safely interrupt 10,000 amperes of short-circuit current. BUSS One-Time fuses will carry 110% load when tested in the open or 100% when tested in an enclosure. They will, like all other fuses listed by Underwriters' Laboratories, Inc., open at 135% load within one hour (on 0 to 60 ampere sizes) or two hours (on larger sizes) when tested in the open. This would be found equivalent to opening at 125% load when in an enclosure.

Application

These fuses are usually applied to protect lighting, heating and other non-transient circuits where available short-circuit currents are relatively low. One-Time fuses do not have any appreciable degree of time-delay; thus, should not be specified in circuits where large transient conditions could be experienced. If surges or motor starting currents make heavier fuses necessary, use time-delay FUSETRON dual-element fuses. (Ask for Bulletin FIS.)

Underwriters' Laboratories Inc. Listed
Listed by © Canadian Standards Association

For voltages up to 250V ac or dc			For voltages up to 600 V ac or dc		
Symbol & Amperes	Carton Quan.	Lbs. per 100	Symbol & Amperes	Carton Quan.	Lbs. per 100
NON 1			NOS 1		
NON 3			NOS 3		
NON 6			NOS 6		
NON 10	10	3.8	NOS 10	10	14.5
NON 15			NOS 15		
NON 20			NOS 20		
NON 25			NOS 25		
NON 30			NOS 30		
NON 35			NOS 35		
NON 40			NOS 40		
NON 45	10	10	NOS 45	10	26
NON 50			NOS 50		
NON 60			NOS 60		
NON 70			NOS 70		
NON 80	5	32	NOS 80	5	56
NON 90			NOS 90		
NON 100			NOS 100		
NON 110			NOS 110		
NON 125			NOS 125		
NON 150	1	79	NOS 150	1	124
NON 175			NOS 175		
NON 200			NOS 200		
NON 225			NOS 225		
NON 250			NOS 250		
NON 300	1	165	NOS 300	1	303
NON 350			NOS 350		
NON 400			NOS 400		
NON 450			NOS 450		
NON 500	1	276	NOS 500	1	463
NON 600			NOS 600		

DIMENSIONS
250 Volt

Symbol & Amperes	Length over all	Dia. of Tube	Dia. over Ferrules	Contact Blade Thickness	Contact Blade Width	Contact Blade Lath.
NON 0 to 30	2"	1/2"	9/16"			
NON 35 to 60	3"	3/4"	13/16"			
NON 70 to 100	5 7/8"	1"		1/8"	3/4"	1"
NON 110 to 200	7 1/8"	1 1/2"		3/16"	1 1/8"	1 3/8"
NON 225 to 400	8 5/8"	2"		1/4"	1 5/8"	1 7/8"
NON 450 to 600	10 3/8"	2 1/2"		1/4"	2"	2 1/4"

600 Volt

Symbol & Amperes	Length over all	Dia. of Tube	Dia. over Ferrules	Contact Blade Thickness	Contact Blade Width	Contact Blade Lath.
NOS 0 to 30	5"	3/4"	13/16"			
NOS 35 to 60	5 1/2"	1"	1 5/16"			
NOS 70 to 100	7 7/8"	1 1/4"		1/8"	3/4"	1"
NOS 110 to 200	9 5/8"	1 3/4"		3/16"	1 1/8"	1 3/8"
NOS 225 to 400	11 3/8"	2 1/2"		1/4"	1 5/8"	1 7/8"
NOS 450 to 600	13 3/8"	3"		1/4"	2"	2 1/4"

FOR DETAILED INFORMATION — ASK FOR BUSS BULLETIN NCS

4/24/87, Rev. 0

Class H and K Dimension Fuse Blocks

Dimensions of "1B" Series

Quick Select Table on Page 3

- General Purpose Phenolic Base
- U.L. Listed
- Copper Tin Plate Clips

250 VOLT 1 POLE FERRULE ONLY

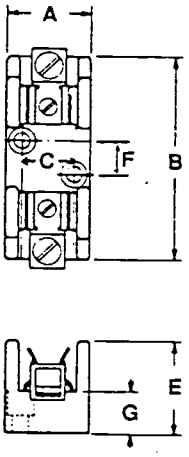


FIG. 1

250 VOLT 2 & 3 POLE FERRULE ONLY

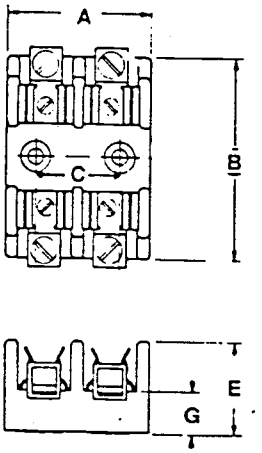


FIG. 2

250 VOLT/600 VOLT 1 POLE FERRULE OR KNIFE BLADE

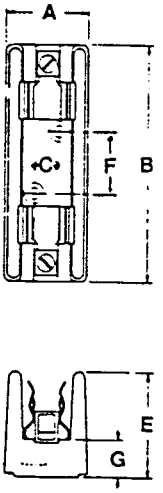


FIG. 3

250 VOLT/600 VOLT 2 & 3 POLE FERRULE OR KNIFE BLADE

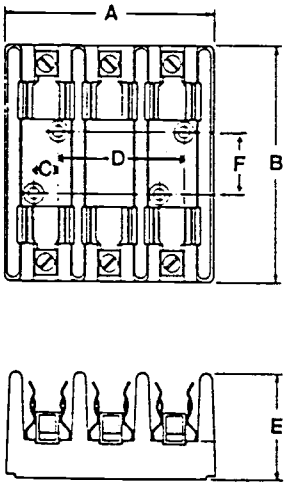


FIG. 4

250 VOLT/600 VOLT 1 POLE KNIFE BLADE ONLY

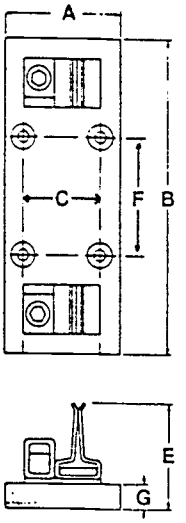


FIG. 5

250 VOLT

FUSE BLOCK	POLES	FUSE AMP RATING	A	B	C	D	E	F	G	HOLE DIAM.	C'BORE DIAM.	MAX. WIRE	CONNECTION	BARRIER	FIG
1B0001	1	1/10-30	1 7/32	3	3/4	—	1 3/8	1/2	5/8	7/32	3/8	10AWG	Screw	Yes	1
1B0002	2	1/10-30	2 5/32	3	1 1/4	—	1 3/8	—	5/8	7/32	3/8	10AWG	Screw	Yes	2
1B0003	3	1/10-30	3 1/8	3	2 1/2	—	1 3/8	—	5/8	7/32	3/8	10AWG	Screw	Yes	2
1B0004	1	1/10-30	1 7/32	3	3/4	—	1 3/8	1/2	5/8	7/32	3/8	10AWG	Sems Press	Yes	1
1B0005	2	1/10-30	2 5/32	3	1 1/4	—	1 3/8	—	5/8	7/32	3/8	10AWG	Sems Press	Yes	2
1B0006	3	1/10-30	3 1/8	3	2 1/2	—	1 3/8	—	5/8	7/32	3/8	10AWG	Sems Press	Yes	2
1B0007	1	1/10-30	1 7/32	3	3/4	—	1 3/8	1/2	5/8	7/32	3/8	2AWG	Box	Yes	1
1B0008	2	1/10-30	2 5/32	3	1 1/4	—	1 3/8	—	5/8	7/32	3/8	2AWG	Box	Yes	2
1B0009	3	1/10-30	3 1/8	3	2 1/2	—	1 3/8	—	5/8	7/32	3/8	2AWG	Box	Yes	2
1B0010	1	31-60	1 11/16	4 3/4	1/2	—	2 1/8	1 1/4	3/4	7/32	13/32	2AWG	Box	Yes	3
1B0011	2	31-60	3	4 3/4	1/2	1 5/16	2 1/8	1 1/4	3/4	7/32	13/32	2AWG	Box	Yes	4
1B0012	3	31-60	4 5/16	4 3/4	1/2	2 5/8	2 1/8	1 1/4	3/4	7/32	13/32	2AWG	Box	Yes	4
1B0013	1	31-60	1 11/16	4 3/4	1/2	—	2 1/8	1 1/4	3/4	7/32	13/32	2AWG	Screw	Yes	3
1B0014	2	31-60	3	4 3/4	1/2	1 5/16	2 1/8	1 1/4	3/4	7/32	13/32	2AWG	Screw	Yes	4
1B0015	3	31-60	4 5/16	4 3/4	1/2	2 5/8	2 1/8	1 1/4	3/4	7/32	13/32	2AWG	Screw	Yes	4
1B0016	1	61-100	1 31/32	8	5/8	—	2 1/2	2 3/8	9/16	9/32	1/2	1/0	Box	Yes	3
1B0017	2	61-100	3 17/32	8	5/8	1 9/16	2 1/2	2 3/8	9/16	9/32	1/2	1/0	Box	Yes	4
1B0018	3	61-100	5 3/32	8	5/8	3 1/8	2 1/2	2 3/8	9/16	9/32	1/2	1/0	Box	Yes	4
1B0019	1	101-200	3	8	2	—	2 9/16	3	5/8	9/32	5/8	250MCM	Box	No	5
1B0021	3	101-200	7 1/2	9 13/16	7/8	5	2 9/16	3 1/2	5/8	9/32	5/8	250MCM	Box	No	4
1B0023	1	201-400	3 1/2	11 1/2	2 1/4	—	2 15/16	3 3/4	5/8	9/32	9/16	350MCM	Box	No	5

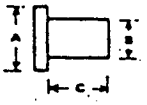
600 VOLT

1B0024	1	1/10-30	1 15/16	6 3/4	5/8	—	2 1/8	3 1/8	3/4	9/32	1/2	10AWG	Screw	Yes	3
1B0025	2	1/10-30	3 1/2	6 3/4	5/8	1 9/16	2 1/8	3 1/8	3/4	9/32	1/2	10AWG	Screw	Yes	4
1B0026	3	1/10-30	5 1/16	6 3/4	5/8	3 1/8	2 1/8	3 1/8	3/4	9/32	1/2	10AWG	Screw	Yes	4
1B0027	1	1/10-30	1 15/16	6 3/4	5/8	—	2 1/8	3 1/8	3/4	9/32	1/2	10AWG	Sems Press	Yes	3
1B0028	2	1/10-30	3 1/2	6 3/4	5/8	1 9/16	2 1/8	3 1/8	3/4	9/32	1/2	10AWG	Sems Press	Yes	4
1B0029	3	1/10-30	5 1/16	6 3/4	5/8	3 1/8	2 1/8	3 1/8	3/4	9/32	1/2	10AWG	Sems Press	Yes	4
1B0030	1	1/10-30	1 15/16	6 3/4	5/8	—	2 1/8	3 1/8	3/4	9/32	1/2	2AWG	Box	Yes	3
1B0031	2	1/10-30	3 1/2	6 3/4	5/8	1 9/16	2 1/8	3 1/8	3/4	9/32	1/2	2AWG	Box	Yes	4
1B0032	3	1/10-30	5 1/16	6 3/4	5/8	3 1/8	2 1/8	3 1/8	3/4	9/32	1/2	2AWG	Box	Yes	4
1B0033	1	31-60	1 15/16	6 3/4	5/8	—	2 1/8	3 1/8	3/4	9/32	1/2	2AWG	Box	Yes	3
1B0034	2	31-60	3 1/2	6 3/4	5/8	1 9/16	2 1/8	3 1/8	3/4	9/32	1/2	2AWG	Box	Yes	4
1B0035	3	31-60	5 1/16	6 3/4	5/8	3 1/8	2 1/8	3 1/8	3/4	9/32	1/2	2AWG	Box	Yes	4
1B0039	1	61-100	2 7/32	10	7/8	—	2 1/2	4 1/4	9/16	9/32	1/2	1AWG	Box	Yes	3
1B0040	2	61-100	4 1/32	10	7/8	1 13/16	2 1/2	4 1/4	9/16	9/32	1/2	1AWG	Box	Yes	4
1B0041	3	61-100	5 27/32	10	7/8	3 5/8	2 1/2	4 1/4	9/16	9/32	1/2	1AWG	Box	Yes	4
1B0042	1	101-200	3	10 1/2	2	—	2 9/16	3	5/8	9/32	5/8	250MCM	Box	No	5
1B0043	1	201-400	3 1/2	14 1/2	2 1/4	—	2 15/16	3 3/4	5/8	9/32	9/16	350MCM	Box	No	5
1B0048	3	101-200	7 1/2	12 1/16	7/8	5	2 9/16	6	5/8	9/32	5/8	250MCM	Box	No	4

Round and Rectangular Panel Meters

Simpson

SIZE CHART			
Model	A	B	C
25, 55	3.50"	2.75"	1.31"
27, 47, 57	3.12"	2.75"	1.36"
29, 59	4.20"	2.75"	1.00"
77	3.12"	2.75"	2.11"
79	4.20"	2.75"	1.68"
142	3.94"	3.25"	1.00"



All DC meters have the Simpson self shielded movement and are self contained for ranges up to and including 50 amperes. Higher range DC ammeters (50MV) listed are calibrated for 5 ft. leads and require external shunts. Accuracy ±2% of full scale.

Model 27

Model 25

Model 29

AC VOLTMETER Iron Vane Type Movement

Range	Res. ohms	3½" Case Model 25	3½" Case Model 27	3½" Case Each	4½" Case Model 29	4½" Case Each
0-5	1000 ohms per volts	.....	55F039	41.10	55F251	44.70
0-15		.....	.....		.....	
0-25		.....	55F038		.....	
0-30		55F1112	.....	41.10	55F145	40.05
0-50		55F1015	55F043		55F183	
0-100		62F3253	.....		55F252	
0-150		.....	55F045		55F170	
0-250		55F1018	.....	41.10	.....	.....
0-300		.....	.....	.....	55F184	44.70
0-3000†	2000 ohm/vt.	.....	.....	.....	55F255	59.70
.....		.....	.....	.....	.....	.....

(†) External multipliers model 183 furnished with meter.

Range	Approx. Imp. Ohms.. 60 Hz	3½" Case Model 55	3½" Case Model 57	3½" Case Each	4½" Case Model 59	4½" Case Each
0-10	133	55F1067	.....	37.95	.....	.....
0-50	33,333	55F1069	.....	37.95	.....	.....
0-150	25,000	55F1071	55F115	40.35	55F181	44.10
0-250	41,166	.....	55F273	40.35	62F3296	44.10
0-300	50,000	55F1072	62F3291	40.35	55F191	43.20
0-500†	83,333	.....	.....	.....	55F192	54.45
0-1000†	166,666	.....	55F275	59.25	.....	60.90

(†) External multipliers model 183 furnished with meter.

DC MICROAMMETERS Self-Shielding Meter Movement

0-50	1800	55F1031	.....	48.75	.....	.....
0-50	1800	.....	55F071	48.75	55F176	52.35
0-100	1800	.....	55F072	44.70	55F177	49.65

AC AMMETERS Iron Vane Type Meter Movement

0-3	.028	.....	.....	.....	55F194	38.25
0-5	.008	55F1088	.....	36.15	55F195	38.25
0-10	.004	55F1089	55F134	36.15	55F196	38.25
0-15	.0025	55F1119	55F156	36.15	55F282	38.25
0-25	.002	55F1090	55F135	37.65	55F197	39.90
0-50	.001	55F1091	55F136	37.65	55F219	39.90
0-100**	.008	55F1121	.....	36.15	55F284	38.25

(**) Require external transformer.

DC AMMETERS Self-Shielding Meter Movement

0-2	.025	.....	.....	39.90	55F259	43.20
0-3	.0166	55F1057	.....		55F260	
0-5	.010	.....	.....		55F210	
0-10	.005	.....	55F064	39.90	55F211	43.20
0-25	.0020	55F1060	.....		55F261	
0-30	.0017	.....	55F4828		.....	
0-50	.001	.....	.....	39.90	55F212	43.20
0-200*	10.0	62F3268	.....		.....	
0-300*	10.0	.....	.....		62F3279	
0-500*	10.0	.....	.....		62F3280	
50-0-50	.0017	55F1062	.....	41.85	.....	.....

(*) Require external shunt.

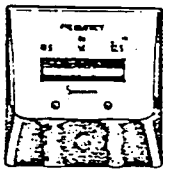
WATTMETERS Dynamometer Type Single Phase Accuracy ±2%

Range	Maximum Volts	Maximum Amps	Model 79 Stock No.	Model 79 Each
0-75	150	1.0	55F232	97.80
0-150	150	2.0	55F233	
0-300	150	4.0	55F234	
0-750	150	10.0	55F235	103.95
0-1500	300	10.0	55F236	
0-3000	300	20.0	55F1140	

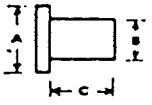
FREQUENCY METERS — RESONANT TYPE

Stock No.	Hz Rating	Case Mod.	Case Size	Case Style	No. Reed	Hz Between Reeds	Type No.	Each
57F2463	55-60-65	2163	3½"	Century	11	1	03496	*86.70
55F5180	47.5-50-52.5	2163	3½"	Century	11	.5	03490	86.70
55F5181	57.5-60-62.5	2163	3½"	Century	11	.5	03491	80.25

Frequency: 50, 60, or 400 Hz. nom. No. of reeds: 11 general purpose, 21 high resolution. Accuracy ±0.3% of mid-scale. Temp. Coeff. −0.017% per°C max. Operating voltage 100-150VAC. Uses tuned steel reeds to indicate AC frequency.



2½" and 3½" AC ELAPSED TIME METERS



SIZE CHART			
Model	A	B	C
108 ET	2.69	2.20	2.30
55 ET	3.50	2.75	2.55
57 ET	3.12	2.75	2.60
1357 ET	3.25	2.75	2.37
2153 ET	3.00	2.69	1.34

55 ET

57 ET

1357 ET

2153 ET

Widely used by research laboratories, manufacturing plants, and broadcast stations. 120 or 240 V AC operation. Synchronous accuracy. Model 55 ET; Standard round styling. Model 57 ET; Standard rectangular styling. Model 108 ET; Interchangeable round and square front mounting bezels. Model 1357 ET: Wide-Vue styling. Model 2153 ET: Century Series styling.

120 VAC Models (±10%) 60 Hz

Maximum Indication (Hours)	Power Req.	Acc.	Model Size	Model (Type) No.	Stock No.	Each
99,999.9*	5 W	synch.	3½"	55 ET	55F4359	47.55
99,999.9	5 W	synch.	3½"	1357 ET	55F4360	47.55
99,999.9	5 W	synch.	3½"	57 ET	55F4361	47.55
99,999.9	5 W	synch.	3½"	2153 ET	55F2473	47.55

240 VAC Models (±10%) 60 Hz

Maximum Indication (Hours)	Power Req.	Acc.	Model Size	Model (Type) No.	Stock No	Each
99,999.9	5 W	synch.	3½"	55 ET	55F4363	47.85
99,999.9	5 W	synch.	3½"	57 ET	55F4364	47.85
99,999.9	5 W	synch.	3½"	1357 ET	55F4365	47.85
99,999.9	5 W	synch.	3½"	2153 ET	55F2475	47.85

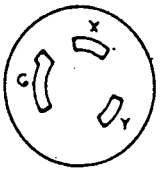
3-WIRE grounding

30A 480V A.C.

TWIST-LOCK®

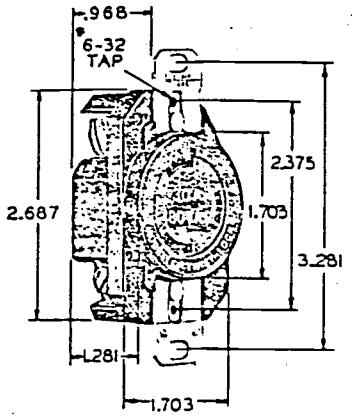
2 POLE, 3 WIRE

NEMA Reference:
Receptacle: L8-30R
Plug: L8-30P



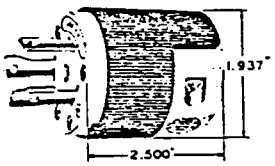
PLUGS, RECEPTACLES AND CONNECT BODIES

FLANGED INLETS, FLANGED RECEPTAC AND "SEAL-TITE" PROTECTION



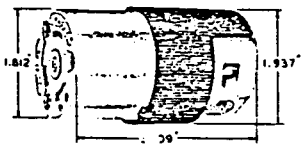
No. 2640

CATALOG NO.	DESCRIPTION	CORD DIA.
2640	Receptacle, Melamine, black	
2641	Plug, nylon Insulgrip	.385—.780
▲SK-2	Shrouding kit for 2641, 2643 combination	
2641-F	Plug, heat stabilized nylon, U.L. temperature Index 220°F continuous use	.385—.780
2641-CY	Plug, Insulgrip, high visibility yellow nylon	.385—.780
■ 26CM41	Plug, yellow nylon, corrosion resistant	.385—.780



No. 2641

CATALOG NO.	DESCRIPTION	CORD DIA.
2643-CY	Plug, Insulgrip, high visibility yellow nylon	.385—.780
2643	Connector body, nylon Insulgrip	.385—.780
2643-F	Connector body, heat stabilized nylon, U.L. temperature Index 220°F continuous use	.385—.780
■ 26CM43	Connector body, yellow nylon, corrosion resistant	.385—.780



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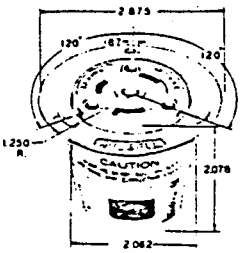

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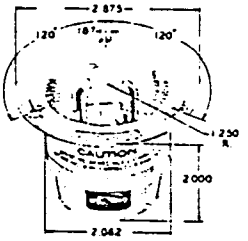
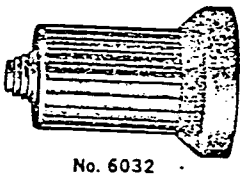


No. 2645

CATALOG NO.	DESCRIPTION
2646	Flanged Receptacle, nylon casing
2646-F	Flanged receptacle, heat stabilize nylon, U.L. temperature Inc 220°F continuous use
2645	Flan J Inlet, nylon casing
2645-F	Flanged Inlet, heat stabilized ny U.L. temperature Index 220 continuous use
2645-WP	Flanged inlet, nylon casing mounted on a gray Polycarbonate weatherproof lift cover plate.
2899	Closure cover for 2645 male



No. 6032

CATALOG NO.	DESCRIPTION
6032	"Seal-Tite", black neoprene tr seal cover for No. 2643 wh used in a cord set
■60CM32	Yellow neoprene "Seal-Tite" t seal cover for 2643

No. 6031

CATALOG NO.	DESCRIPTION
6031	"Seal-Tite" black neoprene tri seal cover for No. 2641 wh used in a cord set and 26 connector when used with Flanged Inlets
■60CM31	Yellow neoprene "Seal-Tite" t seal cover for 2641

PLATES

(SEE PLATE SECTION FOR WEATHERPROOF PLATES

3391	Plate, .040 brass, single gan
3392	Plate, stainless steel, single
3393	Plate, cast aluminum, with li cover, fits F.S. and F.D. bo
3394	Plate, cast aluminum, withou cover, fits F.S. and F.D. bo
3395	Plate, 4" square pressed ste universal box No. 52151
7424	Plate, gray Polycarbonate, we proof, with lift cover
■ 74CM24	Plate, yellow Polycarbonate, corrosion resistant, lift co

SPECIFICATION NOTES

Plugs and connectors have black and white nylon housing
Casings are completely insulated impact resistant nylon

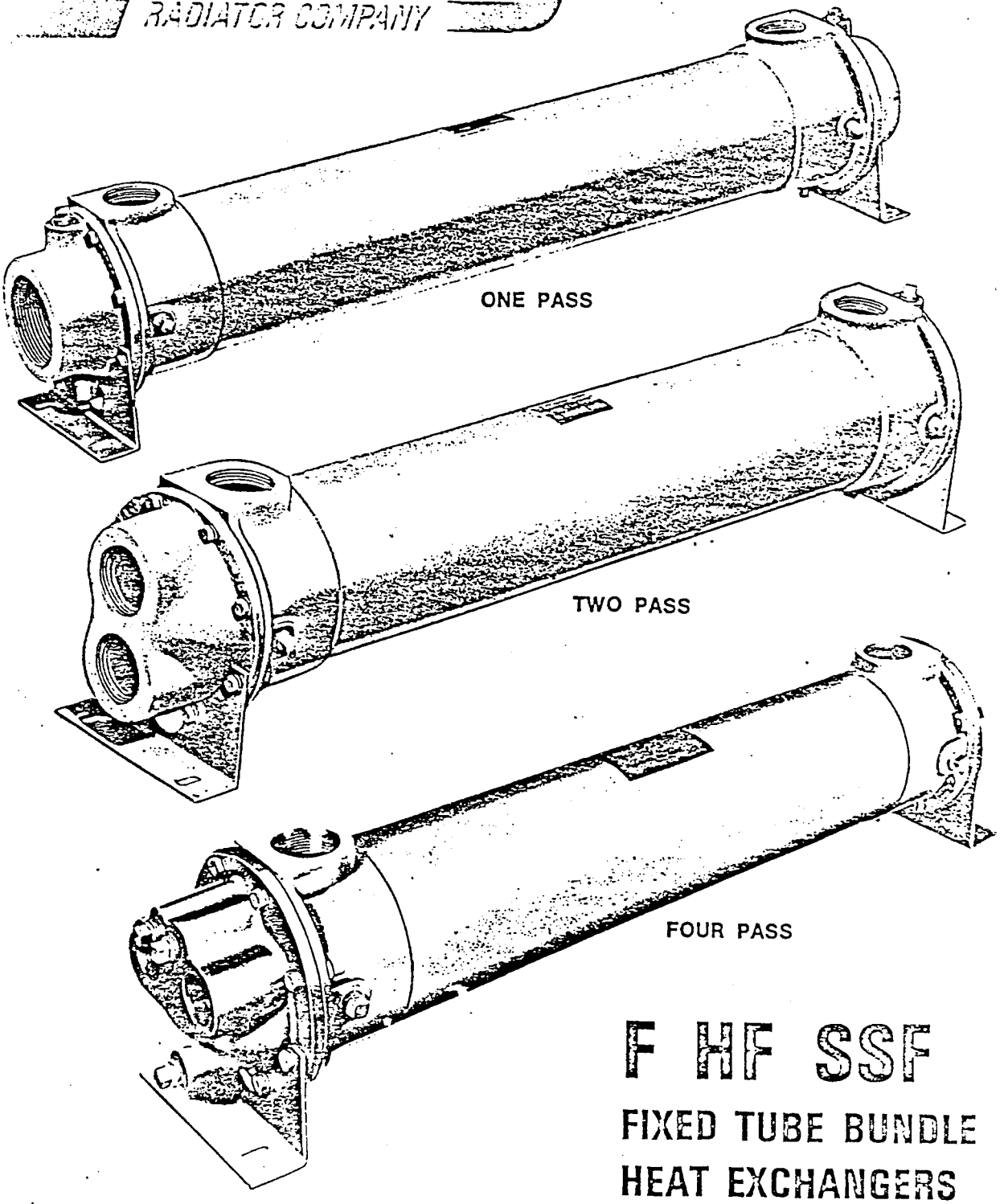
■ For complete corrosion resistant specifications see section
▲ For complete product details see page B-50.

APPENDIX D-13

CONDENSOR SPECIFICATIONS

CATALOG 12 1982
Supersedes Catalog 1280

Young
RADIATOR COMPANY



F HF SSF

FIXED TUBE BUNDLE HEAT EXCHANGERS

YOUNG RADIATOR COMPANY
2825 Four Mile Road • Racine, Wisconsin 53404
Plants at: Racine, WI, Mattoon, IL and Centerville, IA

COPYRIGHT 1982 YOUNG RADIATOR COMPANY

F HF SSF basic information

CONSTRUCTION FEATURES

STURDY BRACKET
Made of heavy gauge steel . . . adjustable for installation in various positions. Rotatable through 360 degrees.

SMOOTH FLOW BONNET
Distributes fluid to tubes with minimum turbulence. One, two or four pass interchangeability.

TUBES
On F and HF, tubes are high temperature bonded into tube sheets. On SSF and F-1000 series, tubes are rolled into tube sheets by electronic control.

END HUB
End hub is high quality forging and/or casting. Full-flow opening is designed for minimum pressure drop.

BAFFLES
Segmented baffles available in five spacings for maximum heat transfer with minimum fluid pressure drop.

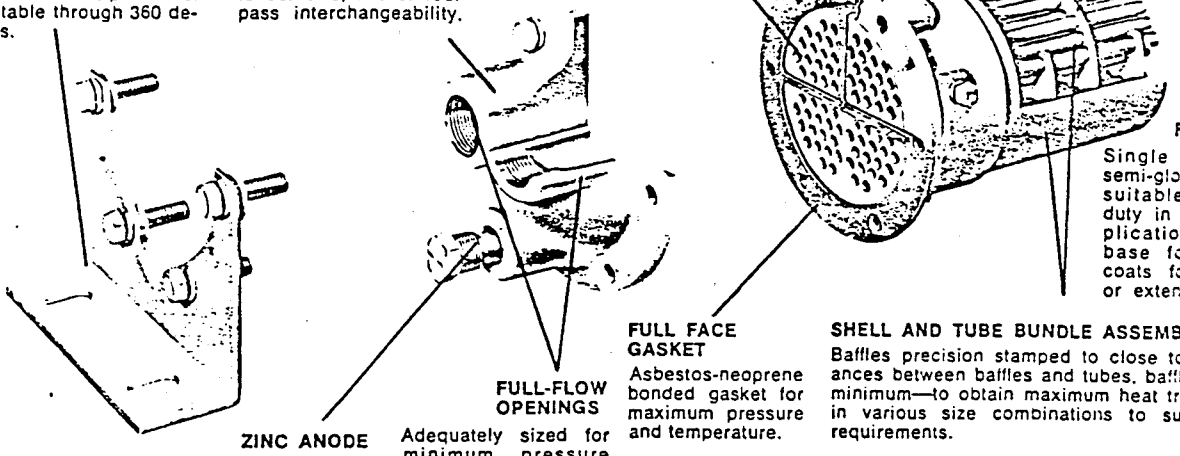


Fig. 7

FINISH
Single coat of grey, semi-gloss enamel paint suitable for outdoor duty in non-critical applications, and as a base for subsequent coats for severe duty or extenced life.

ZINC ANODE
All F and HF heat exchangers are furnished with zinc anodes. These protect the tube metal through sacrificial corrosion. The protective value of the zinc decreases in time due to metal loss. It is recommended they be inspected on a regular basis and be replaced when required.

FULL-FLOW OPENINGS
Adequately sized for minimum pressure drop. Flexible connections are recommended when vibration is present.

FULL FACE GASKET
Asbestos-neoprene bonded gasket for maximum pressure and temperature.

SHELL AND TUBE BUNDLE ASSEMBLY
Baffles precision stamped to close tolerances. Clearances between baffles and tubes, baffles and shell are minimum—to obtain maximum heat transfer. Available in various size combinations to suit heat transfer requirements.

TABLE 1

MODEL IDENTIFICATION

TYPE CODE	SHELL DIAMETER CODE	SHELL LENGTH CODE	BAFFLE SPACING CODE	TUBE DIAMETER CODE	PASS CODE	OPTION CODE
F=fixed tube bundle with **150 psi** 1040 kPa shell HF=fixed tube bundle with **250 psi** 1725 kPa shell SSF=fixed tube bundle with **300 psi** 2070 kPa shell and stainless steel materials	2=2.13 in 3=3.63 in 5=5.13 in 6=6.13 in 8=8.38 in 10=10.75 in	01= 9 in 02=18 in 03=27 in 04=36 in 05=45 in 06=54 in 08=72 in 10=90 in	H=1.13 in D=2.25 in E=4.50 in A=9.00 in T=15 in (approx.)	Y=0.250 in OD R=0.375 in OD C=0.625 in OD	1P=one pass 2P=two pass 4P=four pass	CN=90-10 copper nickel tube CNT=90-10 copper nickel tube and tube sheet B=brass bonnet CNB=90-10 copper nickel tube and brass bonnet CNTB=90-10 copper nickel tube, tube sheet and brass bonnet

NOTE A: F TYPE CODE not available in 2 and 8 SHELL DIAMETER CODE.
NOTE B: HF TYPE CODE not available in 10 SHELL DIAMETER CODE.
NOTE C: HF-2 TYPE CODE, SHELL DIAMETER CODE not available in 2P or 4P PASS CODE.
NOTE D: SSF-3-R TYPE CODE, SHELL DIAMETER CODE and TUBE DIAMETER CODE not available in 4P PASS CODE.
NOTE E: CN OPTION CODE available with 10 SHELL DIAMETER CODE only, all others are CNT OPTION CODE.

NOTE F: MODEL EXAMPLE —

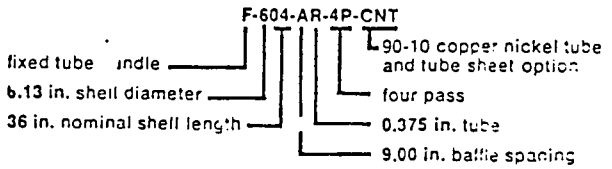


TABLE 2

METRIC CONVERSIONS

VARIABLE	PREFERRED SI UNIT	PREFERRED ABBREVIATION	ALTERNATE UNIT	ALTERNATE ABBREVIATION	CONVERSION MULTIPLIER**
length	metre	m	millimetre	mm	0.001
mass	kilogram	kg	gram	g	0.001
time	second	s	hour*	hr	0.0002777
heat energy	joule	J	calorie*	cal	4.187
force	newton	N	kilogram-force*	kgf	9.81
power	watt*	W	joule/second	J/s	1.0
pressure	newton/metre²	N/m²	kilopascal	kPa	1000
volume flow rate	cubic metre/second	m³/s	litre*	l	0.001
volume flow rate	cubic centimetre/second	cm³/s	litre*	l	1000
acceleration	metre/second²	m/s²	—	—	—

*does not conform to SI metric standard
**to convert to preferred, multiply alternate by CONVERSION MULTIPLIER

EXPLANATION OF METRIC NOMENCLATURE

This catalog is dual dimensioned with the primary units being U. S. customary (bold face type) and the secondary dimensions being SI metric as defined in ASTM Designation: E380. Strict conformance to the SI metric standard produces some unfamiliar units in the tables and charts. Particular note should be made of the SI metric units of CAPACITY FACTOR (J/s-C = W/C) and SHIPPING WEIGHT (N). In the former case, the Joule (J) is the preferred unit of heat energy instead of the calorie and the preferred unit of weight or force is the Newton instead of the kilogram-force. Mass is related to force by the formula: force (N) = mass (g) x acceleration (9.8 m/s²). For reference, a tabulation of the metric units used in this catalog is provided as well as selected conversions to other metric units some of which do not conform to the SI standard.

TABLE 3 TECHNICAL SPECIFICATIONS

MECHANICAL DESIGN DATA

RATINGS		TYPE CODE F		TYPE CODE HF		TYPE CODE SSF	
Maximum operating pressure psi kPa	Shell	150	1040	250	1725	300	2070
	Tube	150	1040	150	1040	150	1040
Test pressure psi kPa	Shell	250	1725	500	3450	500	3450
	Tube	250	1725	300	2070	300	2070
Maximum operating temperature F C	Shell	350	177	350	177	400	204
	Tube	350	177	350	177	400	204

MATERIAL DATA

COMPONENT		SHELL DIAMETER CODE	TYPE CODE F	TYPE CODE HF	TYPE CODE SSF
Shell		2 and 8	—	brass	316 stainless steel
		3, 5 and 6	brass	steel	
		10	steel	—	
Baffle		2, 3, 5, 6 and 8	brass		
		10	steel		
Tube		All	admiralty (Cu-Ni if OPTION CODE includes CN)		
Tube sheet		All	brass (Cu-Ni if OPTION CODE includes CNT)		
Bonnet		All	cast iron (cast brass if OPTION CODE includes B)		316 stainless steel casting
Hub		All	brass forging		
Pipe Plug	Shell	All	brass		316 stainless steel
	Bonnet	All	steel (brass if OPTION CODE includes B)		
Mounting Brkt.		All	steel		steel

NOTE G: The differential between the shell fluid average temperature and tube fluid average temperature should not exceed 200F 93C for models through 06 SHELL LENGTH CODE and 150F 70C for longer models. For temperature differences exceeding these limits, heat exchangers should be furnished with expansion joints. To eliminate high pressure surges a pressure relief valve, accumulator or other suitable device should be used with a hydraulic system.

NOTE H: One pass heat exchangers should be used for steam service. Pressures to 75 psig 520 kPa (maximum) and temperatures to 350F 177C (maximum) may be used. Steam should be admitted through the tube side, with the exchanger mounted vertically to permit condensate to drain. A trap of proper type and size should be used. Horizontal installation can be accomplished if the heat exchanger is pitched at least 0.5 in/ft 4 cm/m of tube length.

PHYSICAL DATA

SHELL DIAMETER and LENGTH CODE	SHELL FLUID VOLUME gal l		TUBE FLUID VOLUME gal l		OUTSIDE TUBE SURFACE ft² m² TUBE DIA. CODE Y		TUBE DIA. CODE R		SHIPPING WEIGHT lbs N	
201	0.10	0.38	0.10	0.38	1.52	0.14	—	—	7	31
202	0.15	0.57	0.15	0.57	3.04	0.28	—	—	10	44
301	0.20	0.76	0.15	0.57	3.74	0.33	2.66	0.24	17	75
302	0.50	1.9	0.30	1.1	7.47	0.69	5.31	0.48	25	110
303	0.70	2.6	0.40	1.5	11.1	1.03	7.97	0.73	30	130
502	1.0	3.8	0.50	1.9	18.1	1.68	11.2	1.04	40	180
503	1.5	5.7	0.75	2.8	27.1	2.52	16.8	1.56	50	220
504	2.0	7.6	1.0	3.8	36.1	3.35	22.4	2.08	60	270
602	1.2	4.5	0.90	3.4	26.9	2.50	17.5	1.63	55	240
603	1.9	7.2	1.3	4.9	40.2	3.73	26.2	2.43	70	310
604	2.5	9.5	1.6	6.1	53.6	4.98	34.9	3.24	90	400
606	3.7	14	2.4	9.1	80.8	7.51	52.7	4.90	130	580
608	5.0	19	3.1	12	108	10.0	70.2	6.52	170	750
802	2.4	9.1	1.8	6.8	—	—	34.1	3.17	155	690
803	3.6	14	2.4	9.1	—	—	50.6	4.70	180	800
804	4.7	18	3.1	12	—	—	67.1	6.23	205	910
805	5.8	22	3.7	14	—	—	83.6	7.77	230	1000
806	6.9	26	4.4	17	—	—	100	9.29	265	1200
808	9.1	34	5.6	21	—	—	133	12.4	325	1400
810	11	42	6.9	26	C		166	15.4	405	1900
1005	11	42	7.1	27	74.0	6.87	130	12.1	670	3000
1006	13	49	8.5	32	89.0	8.27	157	14.6	720	3200
1008	18	68	11	42	119	11.1	210	19.5	820	3600
1010	22	83	14	53	149	13.8	263	24.4	920	4100

TABLE 4

CORRECTION TO CAPACITY FACTOR REQUIRED

SHELL LIQUID TYPE	Tsi (temperature of shell liquid at inlet) F C 120 49	150 66	200 93	250 121
SAE 5 oil	1.09	1.03	0.93	0.85
SAE 10 oil	1.19	1.10	1.00	0.92
SAE 20 oil	1.28	1.19	1.06	0.96
SAE 30 oil	1.32	1.27	1.09	0.99
SAE 40 oil	1.37	1.28	1.14	1.02
polyglycol	0.78	0.77	0.72	0.69
phosphate ester	0.67	0.65	0.62	0.60
water	0.59	0.58	0.57	0.57
50% ethylene glycol in water	0.65	0.64	0.62	0.60

TABLE 4A

OIL VISCOSITY
CENTIPOISES = CENTISTOKES X SPECIFIC GRAVITY
For SI Conversion: 1 kg/m-s = 1000 Centipoises

OIL TYPE	VISCOSITY @ 100 F 37.8 C SUS	Centistokes	Centipoise	VISCOSITY @ 210 F 98.9 C SUS	Centistokes	Centipoise
SAE 5	110	24	22	41	4.5	4.0
SAE 10	160	35	32	44	5.5	5.0
SAE 20	270	60	55	50	7.5	7.0
SAE 30	500	110	100	63	11	10
SAE 40	750	170	155	76	14.5	13
polyglycol	210	45	47	52	7.7	7.8
phosphate ester	250	56	66	43	5.1	5.8

TABLE 5

LMTD (Logarithmic Mean Temperature Difference) F or C

Tsi — Tto F or C	Tso — Tti F or C 5	7	10	15	20	25	30	40	50	60	80	100	120
5	5.0	6.0	7.2	9.1	11	12	14	17	20	22	27	32	36
7	6.0	7.0	8.4	10	12	14	16	19	22	25	30	35	40
10	7.2	8.4	10	12	14	16	18	22	25	28	34	39	44
15	9.1	10	12	15	17	20	22	26	29	32	39	45	51
20	11	12	14	17	20	22	25	29	33	36	43	50	56
25	12	14	16	20	22	25	27	32	36	40	47	54	61
30	14	16	18	22	25	27	30	35	39	43	51	58	65
35	15	17	20	24	27	30	32	37	42	46	54	62	69
40	17	19	22	26	29	32	35	40	45	49	58	66	73
45	18	20	23	27	31	34	37	42	47	52	61	69	77
50	20	22	25	29	33	36	39	45	50	55	64	72	80
60	22	25	28	32	36	40	43	49	55	60	70	78	87
70	25	27	31	36	40	44	47	54	60	65	75	84	93
80	27	30	34	39	43	47	51	58	64	70	80	90	99
100	32	35	39	45	50	54	58	66	72	78	90	100	110
120	36	40	44	51	56	61	65	73	80	87	99	110	120

TABLE 6

LIQUID TYPE	LIQUID CONSTANT Btu/gal-F	J/l-C
SAE 5 oil	3.5	1800
SAE 10 oil	3.5	1800
SAE 20 oil	3.5	1800
SAE 30 oil	3.5	1800
SAE 40 oil	3.5	1800
polyglycol	7.2	3600
phosphate ester	3.9	2000
water	8.3	4200
50% ethylene glycol in water	7.3	3700

F HF SSF selection/example

SELECTION

(for cooling liquids with water as coolant in tubes)

1. Specify:
   Ft = cooling water flow in tubes, **gpm** l/s
   Tti = temperature of cooling water at inlet, F C
   Operating pressure of liquid in shell, **psi** kPa
   and specify 3 of the following 4 variables:
   Q = heat load, **Btu/min** J/s
   (**1 hp = 42.4 Btu/min**; 1 kW = 1000 J/s)
   Fs = liquid flow in shell, **gpm** l/s
   Tsi = temperature of shell liquid at inlet, F C
   Tso = temperature of shell liquid at outlet, F C

2. Derive the unspecified variable value using the LIQUID CONSTANT from TABLE 6 in the following equation:
   Q = Fs x (Tsi — Tso) x LIQUID CONSTANT

3. Calculate temperature of cooling water at outlet, **Tto**, from the following formula:
   $$Tto = Tti + \frac{Q}{8.3\ 4200 \times Ft}$$

4. Determine **LMTD** (logarithmic mean temperature difference) F or C from the temperature relationships **Tsi — Tto** and **Tso — Tti** using TABLE 5.

5. Calculate uncorrected CAPACITY FACTOR REQUIRED:
   $$\text{uncorrected CAPACITY FACTOR REQUIRED} = \frac{Q}{LMTD}$$

6. Determine CAPACITY FACTOR REQUIRED for SHELL LIQUID TYPE and **Tsi** by multiplying uncorrected CAPACITY FACTOR REQUIRED by CORRECTION from TABLE 4.

7. Select heat exchanger BASE MODEL from TABLE 9. Starting at the top, select a BASE MODEL with an adequate CAPACITY FACTOR at **Fs** with the desired tube diameter.

8. Calculate pressure loss of shell liquid, **Pls**, using **Fs**; RATED FLOW and RATED PRESSURE LOSS from TABLE 9; and CORRECTION TO PRESSURE LOSS from TABLE 7 using the following formula:
   $$Pls = \left(\frac{Fs}{\text{RATED FLOW}}\right)^2 \times \text{RATED PRESSURE LOSS} \times \text{CORRECTION TO PRESSURE LOSS}$$
   If **Pls** is excessive, select a BASE MODEL with wider BAFFLE SPACING CODE or larger SHELL DIAMETER CODE and repeat steps 7 and 8.

9. Select PASS CODE from TABLE 8 based on MINIMUM FLOW and MAXIMUM FLOW. If **Ft** exceeds MAXIMUM FLOW for PASS CODE 1P, select BASE MODEL with larger SHELL DIAMETER CODE.

10. Calculate pressure loss of tube liquid, **Plt**, using **Ft**; MAXIMUM FLOW, PRESSURE LOSS AT MAXIMUM for 01 SHELL LENGTH CODE from TABLE 8; and SHELL LENGTH CODE in the BASE MODEL from the formula:
    $$Plt = \left(\frac{Ft}{\text{MAXIMUM FLOW}}\right)^2 \times \text{PRESSURE LOSS AT MAXIMUM FOR 01 SHELL LENGTH CODE} \times \text{SHELL LENGTH CODE}$$

TABLE 7

CORRECTION TO PRESSURE LOSS				
LIQUID TYPE	INLET LIQUID TEMPERATURE F C			
	120 49	150 66	200 93	250 121
SAE 5 oil	1.20	1.07	0.89	0.74
SAE 10 oil	1.34	1.20	1.00	0.83
SAE 20 oil	1.48	1.33	1.10	0.92
SAE 30 oil	1.56	1.39	1.15	0.96
SAE 40 oil	1.64	1.47	1.22	1.01
polyglycol	1.64	1.58	1.31	1.14
phosphate ester	1.85	1.57	1.27	1.05
water	0.68	0.65	0.58	0.53
50% ethylene glycol in water	0.93	0.86	0.75	0.65

NOTE J CAPACITY FACTORS are approximate They are based on a modest cooling water velocity in the tubes and a fouling factor of 0.002 min-ft²-F/Btu 0.0058 m²-C/kW Pressure loss calculations are also approximate A rigorous sizing and pressure loss calculation method is available to Young Radiator Company Representatives through time-sharing computer terminals in most offices

EXAMPLE

1. Select a stock heat exchanger to remove **2100 Btu/min** 38 250 J/s from **150 psi** 1040 kPa SAE 30 oil at **150F** 65.5C, cooling to **135F** 57C using **25 gpm** 1.6 l/s of cooling water at **70F** 21C. Maximum allowable pressure loss of shell liquid, **Pls**, is **10 psi** 69 kPa. Maximum allowable pressure loss of cooling water in tubes, **Plt**, is **5 psi** 35 kPa.

2. Calculate liquid flow in shell:
   $$Fs = \frac{Q}{(Tsi - Tso) \times \text{LIQUID CONSTANT}}$$
   $$Fs = \frac{2100\ \ 38250}{(150\ 65.5 - 135\ 57) \times 3.5\ 1800} = 40 \text{ gpm } 2.5 \text{ l/s}$$

3. Calculate temperature of cooling water at outlet:
   $$Tto = 70\ 21 + \frac{2100\ \ 38250}{8.3\ 4200 \times 25\ 1.6} = 80F\ 27C$$

4. Determine **LMTD**:
   Tsi — Tto = 150 66 — **80** 27 = **70F** 39C
   Tso — Tti = 135 57 — **70** 21 = **65F** 36C
   LMTD = 68F 37C

5. Calculate uncorrected CAPACITY FACTOR REQUIRED:
   Uncorrected CAPACITY FACTOR REQUIRED =
   $$\frac{2100\ \ 38250}{68\ \ 37} = 31 \text{ Btu/min-F } 1000 \text{ J/s-C}$$

6. Determine CAPACITY FACTOR REQUIRED:
   CAPACITY FACTOR REQUIRED =
   31 1000 x **1.27 = 39.4** 1270

7. Select BASE MODEL:
   502-DY has adequate CAPACITY FACTOR; however, **Pls** is too high. **502-EY** has adequate CAPACITY FACTOR, appears to have a satisfactory **Pls** and is a normally stocked BASE MODEL in TYPE CODE F which is adequate for operating pressure in shell of **150 psi** 1040 kPa.

8. Calculate **Pls** for 502-EY:
   $$Pls = \left(\frac{40\ \ 2.5}{35\ \ 2.2}\right)^2 \times 2.2\ 15 \times 1.39\ 1.39 = 4.0 \text{ psi } 28 \text{ kPa}$$

9. Select PASS CODE:
   Because the **25 gpm** 1.6 l/s flow is close to the MINIMUM FLOW for 1P and close to the MAXIMUM FLOW for 4P, use 2P.

10. Calculate **Plt** for 2P:
    $$Plt = \left(\frac{25\ \ 1.6}{72\ \ 4.5}\right)^2 \times 2.1\ 15 \times 2\ \ 2 = 0.5 \text{ psi } 3.8 \text{ kPa}$$

DISCUSSION: Select MODEL F-502-EY-2P

If **0.375 in.** instead of **0.250 in.** tubes are required, select MODEL F-503-ER-2P using steps 7 through 10. If seawater is the coolant, select MODEL F-502-EY-2P-CNTB. If oil pressure exceeds operating pressure of TYPE CODE F, consider MODEL HF-502-EY-2P. If stainless steel construction is desired, consider MODEL SSF-502-EY-2P.

TABLE 8

FLOW LIMITS & PRESSURE LOSS IN TUBES										
SHELL DIAMETER CODE	MAXIMUM LIQUID FLOW IN SHELL		PASS CODE	LIQUID FLOW IN TUBES				PRESSURE LOSS AT MAX. PER 01 SHELL LENGTH CODE	
				Minimum		Maximum			
	gpm	l/s		gpm	l/s	gpm	l/s	psi	kPa
2	11	0.69	1P	3.5	0.22	28	1.8	1.2	8.3
3	34	2.1	1P	9.0	0.57	71	4.5	1.2	8.3
			2P	4.5	0.28	31	2.0	2.3	16
			4P	2.2	0.14	17	1.1	6.8	47
5	72	4.5	1P	20	1.3	120	7.6	0.6	4.1
			2P	10	0.63	72	4.5	2.1	15
			4P	5.0	0.32	31	2.0	4.1	28
6	120	7.6	1P	30	1.9	250	15	1.1	7.6
			2P	15	0.95	120	7.6	2.7	19
			4P	7.5	0.47	61	3.8	6.7	46
8	220	14	1P	57	3.6	460	29	0.6	4.1
			2P	29	1.8	180	11	1.1	7.6
			4P	14	0.88	115	7.2	4.1	28
10	590	37	1P	100	6.3	680	43	0.6	4.1
			2P	50	3.2	340	21	1.5	10
			4P	25	1.6	170	11	3.7	26

NOTE K: Maximum liquid flows in shell, gpm l/s, in TABLE 8 correspond to largest baffle spacing. Flow ranges for individual Base Models are shown in TABLE 9. Maximum flow corresponds to velocity in shell and tubes of 8 ft/s 2.4 m/s and minimum velocity in tubes of 1 ft/s 0.3 m/s.

Young capacity factor and pressure loss

ABLE 3

CAPACITY FACTOR and RATED PRESSURE LOSS of SHELL LIQUID															
NORMALLY STOCKED TYPE				BASE MODEL	CAPACITY FACTOR Btu/min-F J/s-C @ liquid flow in shell, Fs, gpm l/s										RATED PRESSURE LOSS OF SHELL LIQUID psi kPa @ RATED FLOW gpm l/s	
F	HF	SSF*	CNT													
				Fs gpm l/s	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	•	•	•	201-HY	2.9	92	3.6	114	3.9	123	4.2	133	4.4	139	4.5	32
	•	•		202-HY	5.8	183	7.2	228	7.9	250	8.3	262	8.7	275	9.1	63
				Fs gpm l/s	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
•	•	•	•	301-HY	6.3	199	7.7	243	8.7	275	9.4	297	9.9	313	2.6	18
•	•	•	•	302-HY	13	420	16	518	18	579	19	610	20	638	8.3	57
•		•		303-HY	20	635	25	777	27	863	30	935	31	980	14.2	98
				Fs gpm l/s	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
•				301-DY	6.9	218	8.4	265	9.3	294	9.9	313	11	332	3.0	21
•				302-DY	14	439	17	531	19	588	20	629	21	657	6.0	42
•				303-DY	21	657	25	796	28	882	30	942	31	989	9.3	62
				Fs gpm l/s	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
•		•		301-EY	6.4	202	7.3	231	8.0	253	8.5	269	8.9	281	0.5	4
•	•	•	•	302-EY	13	408	15	465	16	506	17	547	18	566	1.1	8
•				303-EY	20	619	22	695	24	758	26	815	27	844	1.6	11
				Fs gpm l/s	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
•	•			502-HY	33	1060	41	1310	46	1440	49	1540	51	1600	15.7	109
•				503-HY	51	1610	63	1990	69	2170	73	2300	76	2420	26.7	185
•				504-HY	69	2170	84	2670	93	2940	98	3090	104	3290	37.9	262
				Fs gpm l/s	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
•	•			502-DY	35	1120	43	1340	47	1480	50	1570	52	1650	11.3	78
•				503-DY	52	1650	64	2020	71	2230	75	2360	78	2450	17.1	118
•				504-DY	69	2190	85	2690	94	2970	100	3150	104	3290	22.8	157
				Fs gpm l/s	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
•	•	•	•	502-EY	32	1000	38	1190	41	1290	44	1400	46	1460	2.2	15
•		•	•	503-EY	48	1510	57	1790	61	1940	66	2070	69	2190	3.3	22
•		•		504-EY	64	2010	74	2340	82	2580	87	2760	92	2890	4.3	30
			•	Fs gpm l/s	[illegible]	1.9	[illegible]	2.5	[illegible]	3.2	[illegible]	3.6	70	4.4	[illegible]	[illegible]
				502-AY	32	1000	35	1100	38	1190	39	1240	41	1310	0.6	4.0
				503-AY	53	1670	57	1800	60	1910	63	2000	66	2090	2.0	13
				504-AY	63	2000	70	2210	75	2360	78	2480	82	2600	1.2	8
				Fs gpm l/s	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
•				602-HY	45	1410	56	1750	62	1960	67	2120	70	2220	8.8	61
				603-HY	70	2200	86	2710	97	3070	105	3290	110	3440	17.8	123
				604-HY	95	3000	115	3670	130	4110	140	4390	145	4610	27.2	188
				606-HY	140	4460	175	5590	195	6190	210	6570	—	—	40.6	280
				Fs gpm l/s	[illegible]	0.63	[illegible]	1.3	[illegible]	2.2	[illegible]	3.2	[illegible]	[illegible]	[illegible]	[illegible]
•				602-DY	45	1420	56	1760	65	2040	71	2260	75	2370	5.7	40
•				603-DY	70	2220	87	2750	100	3150	110	3410	115	3600	11.8	81
•				604-DY	94	2970	115	3670	135	4230	145	4580	155	4830	17.9	124
				606-DY	145	4550	175	5560	205	6480	220	6950	230	7330	30.5	211
				608-DY	190	—	235	7490	275	8630	300	9480	—	—	43.3	299
				Fs gpm l/s	[illegible]	1.3	[illegible]	2.5	[illegible]	3.6	[illegible]	5.0	[illegible]	6.3	[illegible]	[illegible]
•				602-EY	50	1560	61	1930	67	2110	72	2260	75	2360	5.0	34
•				603-EY	74	2330	92	2910	100	3220	110	3440	110	3540	7.4	50
•			•	604-EY	99	3110	120	3820	135	4230	145	4520	150	4770	9.9	68
•				606-EY	150	4710	180	5750	200	6380	215	6760	225	7110	14.8	102
•				608-EY	196	6190	240	7650	270	8560	285	9010	305	9610	19.7	136
				Fs gpm l/s	[illegible]	2.5	[illegible]	3.8	[illegible]	5.0	[illegible]	6.3	[illegible]	7.6	[illegible]	[illegible]
				602-AY	49	1550	56	1760	61	1920	64	2020	68	2130	1.2	8
				603-AY	81	2550	92	2900	97	3070	105	3250	110	3440	4.0	27
•				604-AY	98	3100	110	3540	120	3860	130	4040	135	4230	2.4	16
•				606-AY	150	4680	165	5280	185	5810	195	6160	200	6350	3.6	25
•				608-AY	195	6190	225	7080	240	7620	255	8090	270	8470	4.8	33
				Fs gpm l/s	2.0	0.13	5.0	0.32	8.0	0.50	11	0.69	14	0.83	3.0	0.50
•				301-HR	3.7	117	5.0	158	5.8	183	6.3	199	6.6	207	1.6	11
•		•		302-HR	7.8	246	11	332	12	379	13	417	14	433	5.0	35
				303-HR	12	373	16	515	19	585	20	626	21	664	8.6	60
				Fs gpm l/s	[illegible]	0.63	15	0.95	20	1.3	25	1.6	[illegible]	1.9	20	1.3
				301-DR	5.5	174	6.1	193	6.5	205	7.0	221	7.1	224	2.7	19
				302-DR	11	343	12	386	13	414	14	436	14	452	5.5	38
•				303-DR	16	518	19	588	20	619	21	651	22	679	8.2	57
				Fs gpm l/s	[illegible]	0.63	15	0.95	20	1.3	25	1.6	[illegible]	1.9	20	1.3
•				301-ER	4.5	142	5.0	158	5.5	174	5.8	183	6.2	196	0.4	3
•				302-ER	8.8	278	10	319	11	348	12	370	12	389	0.8	6
•				303-ER	13	417	15	474	16	518	16	553	18	578	1.2	8
				Fs gpm l/s	4.0	0.25	8.0	0.50	12	0.76	16	1.0	20	1.3	12	0.76
•		•		502-HR	18	581	23	736	26	806	28	872	29	910	7.9	55
•				503-HR	28	894	35	1110	39	1230	42	1320	44	1390	13.4	93
				504-HR	38	1210	47	1490	53	1670	56	1760	59	1850	19.1	132
				Fs gpm l/s	8.0	0.50	18	1.1	28	1.8	38	2.4	48	3.0	28	1.8
•				502-DR	20	616	25	787	27	866	29	926	31	970	7.5	52
				503-DR	29	913	37	1170	42	1320	44	1390	46	1460	11.3	78
				504-DR	39	1220	490	1548	55	1740	59	1850	62	1940	15.1	104
				Fs gpm l/s	15	0.95	25	1.6	35	2.2	45	2.8	55	3.5	35	2.2
•		•	•	502-ER	19	594	22	705	24	771	26	825	27	866	1.6	11
•				503-ER	29	904	33	1060	37	1150	39	1240	41	1300	2.5	17
				504-ER	38	1190	44	1400	49	1550	53	1660	55	1720	3.2	22

*SSF 4P PASS CODE not available from stock.

capacity factor and pressure loss

TABLE 9 (continued)

NORMALLY STOCKED TYPE F	HF	SSF*	CNT**	BASE MODEL	CAPACITY FACTOR Btu/min-F J/s-C @ liquid flow in shell, Fs, gpm l/s										RATED PRESSURE LOSS OF SHELL LIQUID psi	kPa @ RATED FLOW gpm l/s
				Fs gpm l/s	25	1.6	30	2.2	45	2.8	50	3.5	55	4.1	45	2.8
				502-AR	18	562	20	632	21	679	23	720	24	752	0.4	3
				503-AR	29	926	33	1030	35	1120	37	1170	39	1220	1.2	8
				504-AR	36	1130	40	1250	43	1360	46	1440	48	1530	2.2	15
				Fs gpm l/s	5.0	0.32	10	0.63	15	0.95	20	1.3	25	1.6	15	0.95
				602-HR	28	894	35	1120	39	1250	43	1350	45	1410	6.6	46
				603-HR	44	1390	55	1740	60	1910	65	2060	68	2160	13.3	92
				604-HR	59	1870	74	2340	82	2600	89	2800	93	2950	20.3	140
				606-HR	89	2810	110	3510	125	3890	135	4200	140	4360	30.5	210
				Fs gpm l/s	10	0.63	20	1.3	30	1.9	40	2.5	50	3.2	30	1.9
				602-DR	28	885	35	1110	39	1240	42	1330	44	1400	3.3	23
				603-DR	44	1380	54	1710	61	1910	65	2050	69	2170	6.6	46
				604-DR	59	1870	73	2310	82	2600	89	2810	92	2910	10.2	70
				606-DR	91	2890	110	3540	125	3920	135	4230	140	4420	17.3	120
				608-DR	120	3820	150	4710	170	5340	180	5660	190	5970	24.6	170
				Fs gpm l/s	20	1.3	40	2.5	60	3.8	80	5.0	100	6.3	60	3.8
•			•	602-ER	31	986	39	1220	42	1340	46	1440	48	1510	3.7	26
•		•		603-ER	47	1490	57	1800	64	2010	68	2130	71	2250	5.5	39
•			•	604-ER	62	1970	77	2440	85	2690	92	2890	96	3020	7.4	51
•				606-ER	93	2940	115	3600	125	4010	135	4270	145	4520	11.1	76
				608-ER	125	3950	155	4870	170	5340	180	5720	190	6070	14.7	102
				Fs gpm l/s	50	1.9	60	3.2	70	4.4	80	5.7	110	6.9	70	4.4
•				602-AR	29	900	33	1050	37	1170	39	1250	42	1310	0.7	5
				603-AR	47	1480	54	1710	60	1900	64	2010	66	2100	2.3	16
•				604-AR	56	1770	66	2100	73	2310	79	2480	83	2610	1.4	9
				606-AR	84	2660	100	3190	110	3480	120	3730	125	3920	2.1	15
•				608-AR	110	3540	135	4200	145	4610	160	5020	165	5210	2.8	20
				Fs gpm l/s	15	0.95	30	1.9	45	2.8	60	3.8	75	4.7	45	2.8
				802-DR	55	1720	68	2140	75	2390	81	2570	85	2690	4.6	32
				803-DR	86	2730	105	3350	115	3670	125	3950	135	4200	9.4	65
				804-DR	115	3670	145	4520	160	5020	170	5440	175	5560	14.3	99
				805-DR	145	4580	180	5690	200	6260	215	6790	—	—	19.4	134
				806-DR	175	5530	215	6790	240	7550	260	8180	—	—	24.5	169
				808-DR	235	7430	290	9130	320	10100	—	—	—	—	34.8	240
				Fs gpm l/s	25	1.6	50	3.2	75	4.7	100	6.3	125	7.9	75	4.7
	•			802-ER	57	1800	71	2230	78	2470	84	2640	88	2780	3.7	26
				803-ER	90	2850	105	3320	120	3730	125	3950	135	4200	5.6	39
	•		•	804-ER	115	3570	140	4460	160	4990	165	5250	175	5500	7.4	52
	•			805-ER	140	4460	175	5560	195	6190	210	6670	220	6890	9.4	65
				806-ER	170	5370	210	6600	235	7360	255	7990	265	8340	11.2	77
				808-ER	225	7140	285	8940	315	9890	335	10500	350	11000	15.0	104
				810-ER	285	8970	350	11000	390	12400	420	13200	—	—	18.8	130
				Fs gpm l/s	50	3.2	90	5.7	130	8.2	170	10.7	210	13.2	130	8.2
	•			802-AR	57	1790	68	2150	75	2370	81	2540	85	2670	1.4	10
				803-AR	94	2970	110	3510	120	3860	130	4080	135	4230	4.8	34
				804-AR	115	3570	135	4300	150	4770	160	5060	170	5310	2.9	20
				805-AR	150	4800	180	5690	195	6190	210	6600	220	6920	6.0	41
	•			806-AR	170	5400	205	6410	225	7170	240	7580	250	7960	4.3	30
	•			808-AR	225	7140	270	8560	300	9450	325	10300	335	10600	5.8	40
				810-AR	300	9510	360	11300	390	12400	420	13200	440	13800	12.1	83
				Fs gpm l/s	60	3.8	100	6.3	140	8.8	180	11.3	220	13.9	140	8.8
	•		•	805-TR	140	4390	165	5180	180	5690	195	6100	200	6380	2.2	15
				806-TR	160	4990	185	5880	210	6570	225	7080	230	7330	1.6	11
	•			808-TR	220	6950	260	8250	285	9070	305	9570	320	10100	2.9	20
	•			810-TR	250	7960	305	9570	335	10500	360	11300	380	11900	4.3	29
				Fs gpm l/s	50	3.2	100	6.3	150	9.4	200	12.6	250	15.8	150	9.4
				1005-AR	215	8630	265	8440	295	9350	325	10200	335	10600	6.8	47
				1006-AR	250	7840	305	9610	345	10800	370	11800	390	12200	4.9	34
				1008-AR	320	10000	410	12900	460	14600	490	15500	520	16500	6.4	44
				1010-AR	440	13700	550	17200	600	18900	640	20300	680	21600	13.3	92
				Fs gpm l/s	150	9.5	200	12.6	250	15.8	300	18.9	350	22.1	250	15.8
•			•	1005-2R	245	7740	270	8530	285	8970	300	9390	310	9730	2.5	17
				1005-TR	270	8470	290	9200	305	9640	320	10100	330	10500	5.5	38
•				1006-TR	305	9640	335	10600	360	11200	370	11600	390	12200	4.0	27
				1008-TR	420	13300	460	14400	440	15300	510	16200	520	16500	7.3	50
•			•	1010-TR	500	15600	540	17000	570	18000	610	19200	620	19700	10.9	75
				Fs gpm l/s	50	3.2	100	6.3	150	9.4	200	12.6	250	15.8	150	9.4
				1005-AC	110	3410	135	4300	150	4740	165	5180	170	5440	4.0	28
				1006-AC	120	3860	155	4870	175	5500	190	5940	195	6230	2.8	19
				1008-AC	165	5180	205	6480	230	7270	250	7930	265	8440	3.8	26
				1010-AC	215	6790	270	8530	305	9640	325	10300	345	10900	7.8	54
				Fs gpm l/s	150	9.5	200	12.6	250	15.8	300	18.9	350	22.1	250	15.8
				1005-TC	135	4300	150	4710	155	4900	165	5210	170	5370	3.2	22
				1006-TC	155	4870	165	5280	180	5720	185	5910	195	6190	2.3	16
				1008-TC	215	6760	230	7300	245	7740	260	8250	270	8470	4.2	29
				1010-TC	250	7960	270	8560	290	9160	305	9610	320	10000	6.3	43

CAPACITY FACTOR and RATED PRESSURE LOSS of SHELL LIQUID

*SSF 4P PASS CODE not available from stock.
**Stocked 10 SHELL DIAMETER CODE are CN OPTION CODE. CNT OPTION CODE not available.

Young F HF SSF dimensions

2 SHELL DIA. CODE
1P PASS CODE

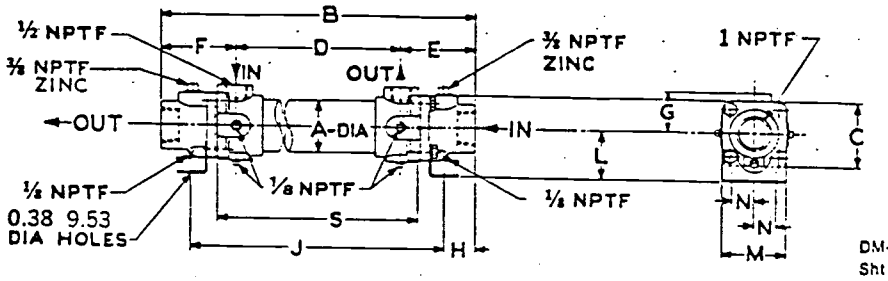


Fig. 8

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3 SHELL DIA. CODE
1P PASS CODE

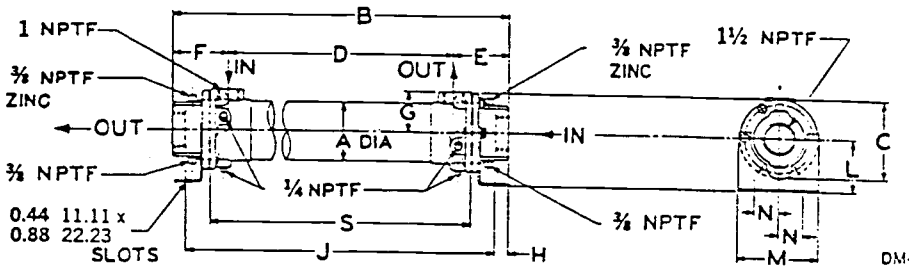

Fig. 9

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3 SHELL DIA. CODE
2P PASS CODE

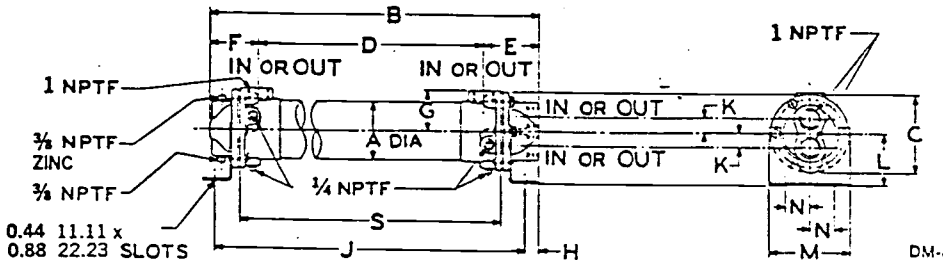

Fig. 10

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3 SHELL DIA. CODE
4P PASS CODE

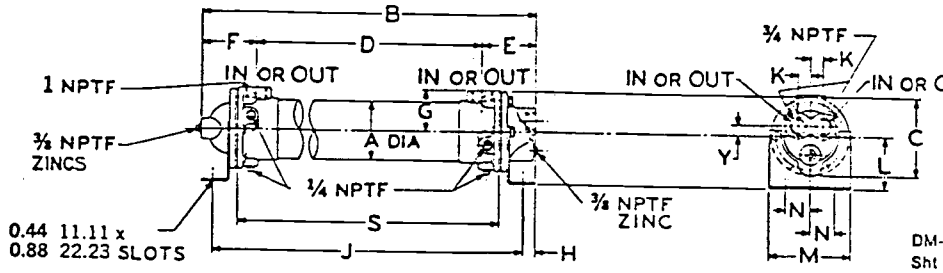

Fig. 11

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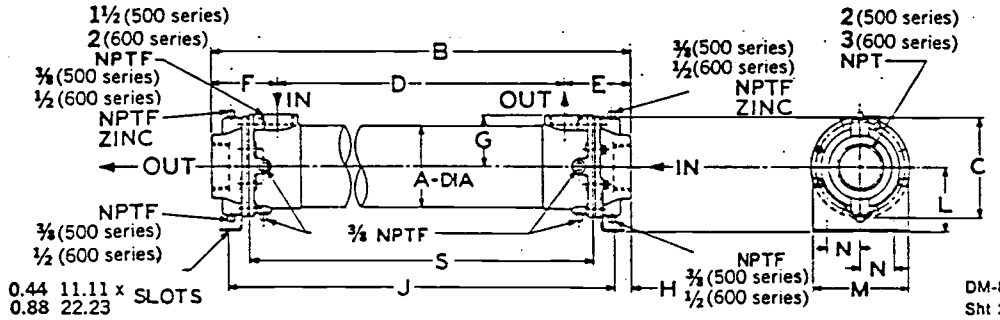
TABLE 10

SHELL DIAMETER & SHELL LENGTH CODE	ALL UNITS									ONE PASS			
	A	C	D	G	J	L	M	N	S	H	B	E	F
201	2.12 53.8	2.50 63.5	7.62 193.5	1.56 39.6	11.06 280.9	1.88 47.7	2.50 63.5	.88 22.3	9.00 228.6	1.16 29.4	13.38 339.8	2.88 73.1	2.88 73.1
202	2.12 53.8	2.50 63.5	16.62 422.1	1.56 39.6	20.06 509.5	1.88 47.7	2.50 63.5	.88 22.3	18.00 457.2	1.16 29.4	22.38 568.4	2.88 73.1	2.88 73.1
301	3.62 91.9	4.88 123.9	7.00 177.8	2.50 63.5	12.38 314.4	3.25 82.5	5.00 127.0	1.50 38.1	9.25 234.9	0.81 20.5	13.88 352.5	3.44 87.3	3.44 87.3
302	3.62 91.9	4.88 123.9	16.00 406.4	2.50 63.5	21.38 543.0	3.25 82.5	5.00 127.0	1.50 38.1	18.25 463.5	0.81 20.5	22.88 581.1	3.44 87.3	3.44 87.3
303	3.62 91.9	4.88 123.9	25.00 635.0	2.50 63.5	30.38 771.6	3.25 82.5	5.00 127.0	1.50 38.1	27.25 692.1	0.81 20.5	31.88 809.7	3.44 87.3	3.44 87.3
502	5.12 130.0	6.50 165.1	15.50 393.7	3.31 84.0	21.62 549.1	4.00 101.6	6.25 158.7	2.00 50.8	18.50 469.9	1.06 26.9	23.62 599.9	4.06 103.1	4.05 103.1
503	5.12 130.0	6.50 165.1	24.50 622.3	3.31 84.0	30.62 777.7	4.00 101.6	6.25 158.7	2.00 50.8	27.50 698.5	1.06 26.9	32.62 828.5	4.06 103.1	4.06 103.1
504	5.12 130.0	6.50 165.1	33.50 850.9	3.31 84.0	39.62 1006.3	4.00 101.6	6.25 158.7	2.00 50.8	36.50 927.1	1.06 26.9	41.62 1057.1	4.06 103.1	4.06 103.1
02	6.12 155.4	7.50 190.5	14.62 371.3	3.81 96.7	21.50 546.1	4.75 120.6	7.25 184.1	2.50 63.5	18.38 466.8	1.31 33.2	24.00 609.6	4.69 119.1	4.69 119.1
03	6.12 155.4	7.50 190.5	23.50 596.9	3.81 96.7	30.38 771.6	4.75 120.6	7.25 184.1	2.50 63.5	27.25 692.1	1.31 33.2	32.88 835.1	4.69 119.1	4.69 119.1
604	6.12 155.4	7.50 190.5	32.38 822.4	3.81 96.7	39.25 996.9	4.75 120.6	7.25 184.1	2.50 63.5	36.12 917.4	1.31 33.2	41.76 1060.7	4.69 119.1	4.69 119.1
606	6.12 155.4	7.50 190.5	50.50 1282.7	3.81 96.7	57.38 1457.4	4.75 120.6	7.25 184.1	2.50 63.5	54.25 1377.9	1.31 33.2	59.88 1520.9	4.69 119.1	4.69 119.1
608	6.12 155.4	7.50 190.5	68.38 1736.8	3.81 96.7	75.25 1911.3	4.75 120.6	7.25 184.1	2.50 63.5	72.12 1831.8	1.31 33.2	77.76 1975.1	4.69 119.1	4.69 119.1

(All dimensions are inches millimetres)

(Certified drawings are available upon request)

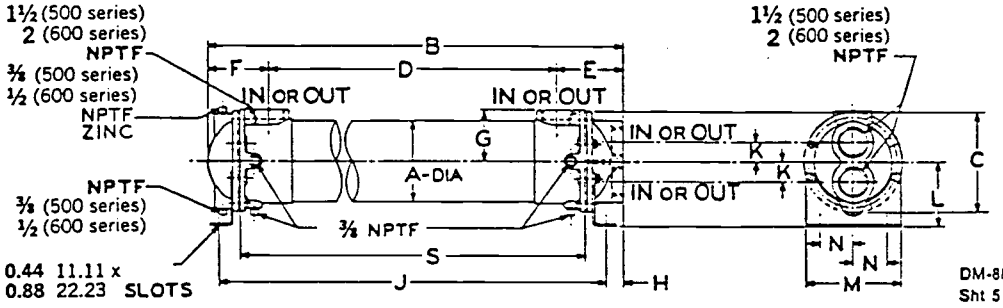
F HF SSF dimensions



5 & 6 SHELL DIA. CODE

1P PASS CODE

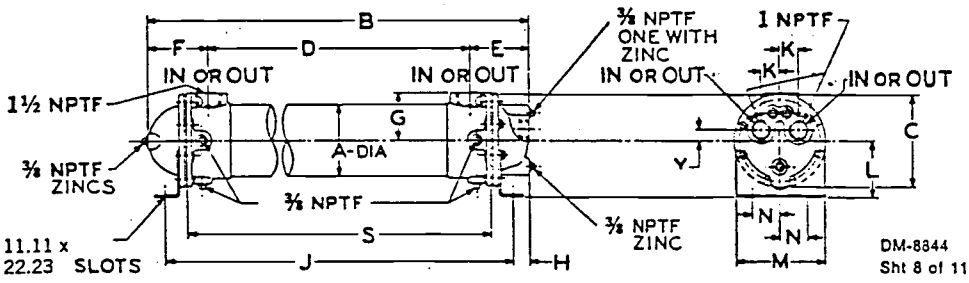
DM-8844
Sht 2 of 11 Fig. 12



5 & 6 SHELL DIA. CODE

2P PASS CODE

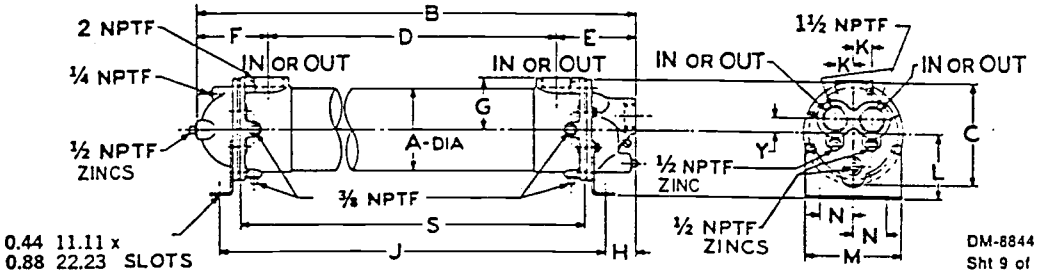
DM-8844
Sht 5 of 11 Fig. 13



5 SHELL DIA. CODE

4P PASS CODE

DM-8844
Sht 8 of 11 Fig. 14



6 SHELL DIA. CODE

4P PASS CODE

DM-8844
Sht 9 of 11 Fig. 15

TWO PASS										FOUR PASS										SHELL DIAMETER & SHELL LENGTH CODE
H		B		E		F		K		H		B		E		F		K		Y		
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	201
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	202
0.81	20.5	13.38	339.8	3.44	87.3	2.94	74.6	0.88	22.3	0.81	20.5	13.62	345.9	3.31	84.0	3.31	84.0	0.75	19.0	0.62	15.7	301
0.81	20.5	22.38	568.4	3.44	87.3	2.94	74.6	0.88	22.3	0.81	20.5	22.62	574.5	3.31	84.0	3.31	84.0	0.75	19.0	0.62	15.7	302
0.81	20.5	31.38	797.0	3.44	87.3	2.94	74.6	0.88	22.3	0.81	20.5	31.62	803.1	3.31	84.0	3.31	84.0	0.75	19.0	0.62	15.7	303
1.06	26.9	23.12	537.2	4.06	103.1	3.56	90.4	1.18	29.9	1.06	26.9	23.62	599.9	4.06	103.1	4.06	103.1	1.34	34.0	0.75	19.0	502
1.06	26.9	32.12	815.8	4.06	103.1	3.56	90.4	1.18	29.9	1.06	26.9	32.62	828.5	4.06	103.1	4.06	103.1	1.34	34.0	0.75	19.0	503
1.06	26.9	41.12	1044.4	4.06	103.1	3.56	90.4	1.18	29.9	1.06	26.9	41.62	1057.1	4.06	103.1	4.06	103.1	1.34	34.0	0.75	13.0	504
1.31	33.2	23.50	596.9	4.69	119.1	4.19	106.4	1.50	38.1	2.18	55.3	25.38	644.6	5.56	141.2	5.19	131.8	1.41	35.8	1.06	26.9	602
1.31	33.2	32.38	822.4	4.69	119.1	4.19	106.4	1.50	38.1	2.18	55.3	34.25	869.9	5.56	141.2	5.19	131.8	1.41	35.8	1.06	26.9	603
1.31	33.2	41.26	1048.0	4.69	119.1	4.19	106.4	1.50	38.1	2.18	55.3	43.13	1095.5	5.56	141.2	5.19	131.8	1.41	35.8	1.06	26.9	604
1.31	33.2	59.38	1508.2	4.69	119.1	4.19	106.4	1.50	38.1	2.18	55.3	61.25	1555.7	5.56	141.2	5.19	131.8	1.41	35.8	1.06	26.9	606
1.31	33.2	77.26	1962.4	4.69	119.1	4.19	106.4	1.50	38.1	2.18	55.3	79.13	2009.9	5.56	141.2	5.19	131.8	1.41	35.8	1.06	26.9	608

(Certified drawings are available upon request)

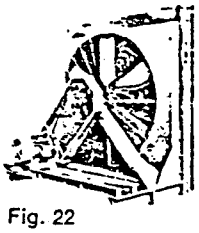


Fig. 22
STANDARD MWC
Water Cooling
Radiator (stock)
Catalog 15
MWC Custom Units
Catalog 13

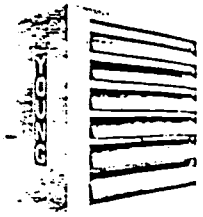


Fig. 23
CI Industrial
Water Cooler (stock)
Catalog 30

Fig. 24
AV Watercooler &
Compressed Air
Aftercooler (stock)
Catalog 14

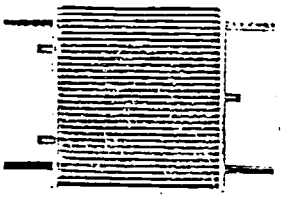


Fig. 25
MOC Mobile Oil
Cooler (stock)
Catalog 24

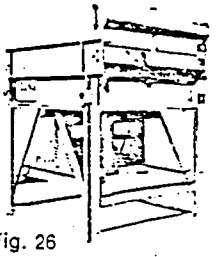


Fig. 26
STANDARD HC
Water Cooling Radiator (stock)
Catalog 17
HC Custom Units
Catalog 13

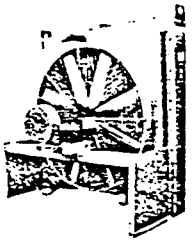


Fig. 27
OCS Oil Cooler
(stock)
Catalog 10

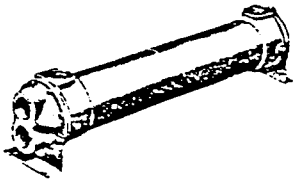


Fig. 28
F Fixed Tube
Bundle Heat Exchanger
(stock)
Catalog 12

Fig. 29
RHF Fixed Tube
Bundle Heat Exchanger
(Stock)
Catalog 12-2P

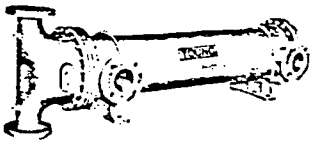


Fig. 30
R Removable Tube
Bundle Heat Exchanger
Catalog 11

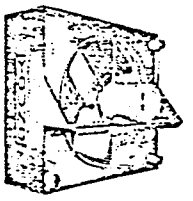


Fig. 31
OCH Oil Cooler
(stock)
Catalog 35

WARRANTY

The Young Radiator Company, hereinafter referred to as the "Company" warrants its commercial or industrial products against defects in material and workmanship under normal use and service for a period of one year from date of shipment from its plants of manufacture.

All obligations and liabilities under this warranty are limited to repairing or replacing, at the Company's option, such allegedly defective products or parts as are returned, carrier charges prepaid, to the plant designated by the Company: 2825 Four Mile Road, Racine, WI 53404; 120 North 14th Street, Mattoon, IL 61938; or Dewey Road, Centerville, IA 52544. All such repairs or replacements are made subject to inspection by the Company of the returned products or parts at the Company's plant. No liability is assumed for costs relating to de-installation or reinstallation.

Warranty on components or accessories furnished by suppliers to the Company shall be limited to the warranty of the respective component or accessory supplier.

The Company shall not be liable for any contingent, incidental or consequential damages for alleged failure or failure of any of its products, components or accessories.

If field service at the request of the Buyer is rendered by the Company, and the alleged fault is found not to be with the Company's product, component or accessory, the Buyer shall pay for the time and expenses of the field representative. Bills for service, labor or other expenses that have been incurred by the Buyer, their customer or agent without approval or authorization by the Company, will not be accepted.

This warranty does not cover failure resulting from improper installation, mounting design or application; nor does it cover failure due to corrosion. The Company's products are not packaged or protected for long periods of storage in generally corrosive atmospheric conditions.

Changes or repairs attempted or made in the field without written authorization from the Company automatically void this warranty.

The Company, whose policy is one of continuous improvement, reserves the right to improve its products through changes in design or material as it may deem desirable without being obligated to incorporate such changes in products of prior manufacture.

SALES AND ENGINEERING OFFICES

See Yellow Pages listing under Heat Exchangers.

*Alabama, Birmingham
*California, Los Angeles
*California, San Francisco
*Colorado, Denver
*Georgia, Atlanta
*Illinois, Chicago
*Indiana, Indianapolis
*Louisiana, New Orleans
*Maryland, Baltimore
*Massachusetts, Boston
*Michigan, Detroit
*Minnesota, St. Paul
*Missouri, Kansas City
*Missouri, St. Louis
*New York, Buffalo
*New York, New York
*North Carolina, Charlotte
*Ohio, Cincinnati
*Ohio, Cleveland
Oklahoma, Oklahoma City
Oklahoma, Tulsa
*Pennsylvania, Philadelphia
*Pennsylvania, Pittsburgh
*Tennessee, Memphis
*Texas, Dallas
*Texas, Houston
Utah, Salt Lake City
*Virginia, Richmond
*Washington, Seattle
Wisconsin, Milwaukee
*Wisconsin, Racine

Alberta, Calgary
*Ontario, Toronto
Winnipeg, Manitoba

*Computer terminal installed for accessing Young Radiator Company stock status and design programs.

YOUNG RADIATOR COMPANY
2825 Four Mile Road • Racine, Wisconsin 53404
Plants at: Racine, WI, Mattoon, IL and Centerville, IA
TELEPHONE: 414-639-1011 • TWX: 910-271-2397 • TELEX: 26-4435

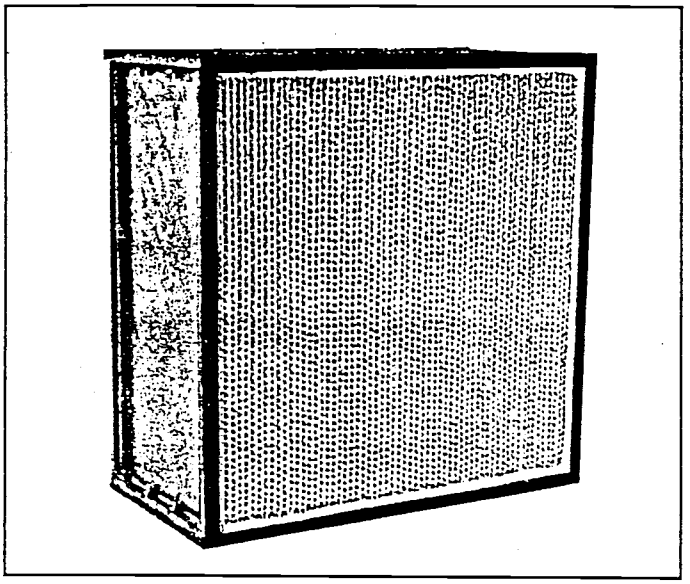
20M 482 M
Litho in U.S.A.

APPENDIX D- 14

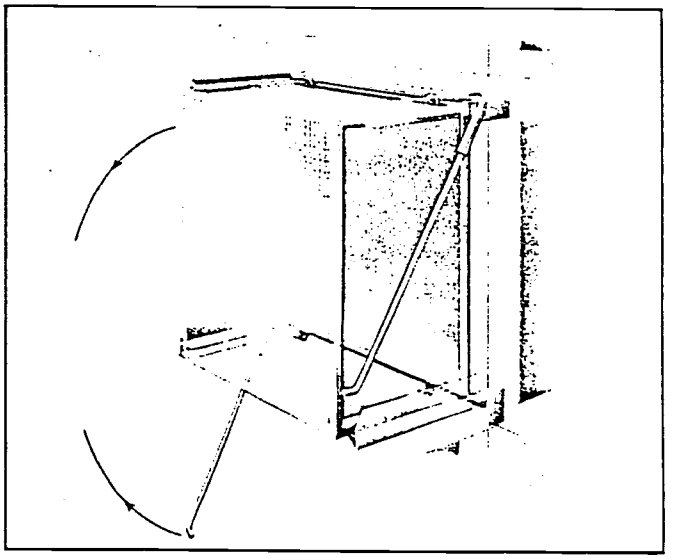
HEPA FILTER SPECIFICATIONS

Nuclear High Efficiency Particulate Air (HEPA) Filter

Astrocel I
Nuclear Series 200
24" x 24" x11-1/2" size - 200 sq. ft. media surface
(610 mm x 610 mm x 290 mm size - 18.6M²)



Astrocel I



Astrocel in Torsion Arm/
Compression Clamp Support Frame

ASTROCEL I DESIGN

The Astrocel I HEPA filter operates on the impaction-diffusion principle to remove ultra fine particles from ventilation and process air using a high ratio (50 to 1) of media area to face area. Air velocity through the media is limited to a maximum of 5 ft. per min. The low flow per sq. ft. of media provides a high dust holding capacity and longer filter life. The high density filtering media (MIL-F-51079) of sub-micron glass fibers is folded into a closely pleated pack (200 sq. ft. surface area). Each pleat is separated by corrugated aluminum (or asbestos) separators which support the media and allow air to flow thru with minimum resistance.

CONSTRUCTION FEATURES

- **Cad plated steel or stainless steel cell sides** (14 ga.) with media pack sealed in neoprene adhesive. Cell sides have media retaining flanges and rigid box flange sealing headers at each face for distortion free clamp sealing. Astrocels may be installed with either face as seal face, neoprene gaskets with interlocking dovetail corners are available on either sealing face. Faceguards of 4 x 4 hardware cloth as media protection on each face and crossed wire bracing (one face) for added protection for extremely rough handling or racking are provided where specified.

- **UL 586 Rated** - Filters qualified under Underwriters Laboratory Test Standard UL 586.

- **AAF Quick Clamp Support Frame** (in AAF Nuclear Filter Units) - Torsion arm compression clamp design permits quick and simple filter changeout; no separate parts, removable pieces, or tools are used. The two bar torsion/four dog clamp design permits quick release of the used filter and its removal by one man. The frame includes two steel support arms on which each HEPA filter rests. Weight of the cell is carried by the frame, not by the operator during changeout. Installation of the new filter is also fast, with positive clamp pressure provided with minimal effort to effect the seal face loading required for leak free operation. The seal faces of the support frame are heavy (11 ga.) stainless or painted carbon steel, cut from a single piece of plate with no welds or other surface variations which can lead to leakage. Seal faces are reinforced by their angle sides bent into the filter opening of the frame.

PERFORMANCE

Flow Capacity: 1000 CFM (1700 M³/hr at 1.0 in. W.G. initial pressure drop

Efficiency: 99.97% by DOP Test Method on 0.3 micron particles.

Resistance at Rated Flow: Maximum initial resistance of 1 in. W.G. (0.25 kPa)
Recommended final resistance of 2 to 3 in. W.G. (0.5 to 0.75 kPa)
Design maximum: 10 in. W.G. (2.5 kPa)

Max. Temperature Limit: 250°F (121°C) continuous service

Better Air is Our Business

Cell Size and Weight: 24" W x 24" H x 11-1/2" D, 46 lbs.
(610 mm x 610 mm x 290 mm, 20.8 Kg)

Surface Area: 200 sq. ft. (18.6 M^2) media surface area

Production Tests:
1. Pressure drop at rated flow
2. DOP penetration tests at 100% and 20% rated flows.

Each cell is tested and labeled with certified test results and serial number.

Optional Test (Extra Cost):
3. U.S. agency reconfirmation tests.

Media Tests: Routine tests on each lot of media: tensiles, wet and dry, DOP penetration, wet strength burst.

Qualification Standards - MIL-F-51069 - Media
MIL-F-51068 - Astrocel I is QPL listed
ANSI N509
UL-586
10CFR50, Appendix B - Quality Program applied to manufacture

Astrocel I Nuclear 200 Series Model Data		
Model No.	Cell Sides	Separators
5N25J6T3B	Cad plated steel	Aluminum
5N26J6T3B	T304 S.S.	Aluminum
5N25K6T3B	Cad Plated steel	Asbestos
5N26K6T3B	T304 S.S.	Asbestos

Optional Features Available (State requirement with model number)
Face guards Cross wire bracing

SUGGESTED ASTROCEL NUCLEAR SERIES 200 SPECIFICATION

All filters shall be of the high efficiency particulate air (HEPA) type. The components shall include *_____cell sides, waterproofed fire-retardant glass fiber media per (MIL-F-51079); *_____separators; neoprene bond; and dovetailed gaskets securely fastened to filter face. The media shall have a minimum thickness of 0.015" + .0003", and a minimum tensile strength of 3.0 pounds per inch. Each filter cell shall withstand a pressure drop of ten inches W.G.

Each filter shall have a nominal rating of 1000 SCFM with a maximum pressure drop of one inch W.G. clean resistance. The exact dimensions of the filter shall be 24" high x 24" wide x 11-1/2" deep.

Each filter shall be individually tested and certified to have an efficiency of not less than 99.97 percent when tested with 0.3 micron dioctyl-phthalate particles. The overall dimensions shall be within +0, -1/8" and squareness of within ±1/8". Filter model no. and performance shall be printed on each filter cell. The filter shall be the ASTROCEL I Nuclear Series as manufactured by American Air Filter Company, Incorporated.

*Select per Model Data.

AAF NUCLEAR ENVIRONMENTAL SYSTEMS include complete systems for cleaning and cooling atmospheric air in nuclear power plants:

- **Air Cleaning Units** with HEPA's, Carbon Adsorbers, Medium & High Efficiency filters, Moisture Separators, Heaters, Coils, Fans.
- **Air Cooling Units** as Containment Coolers, Air Handling Units, Special Coolers, N Stamp Coil Assemblies.

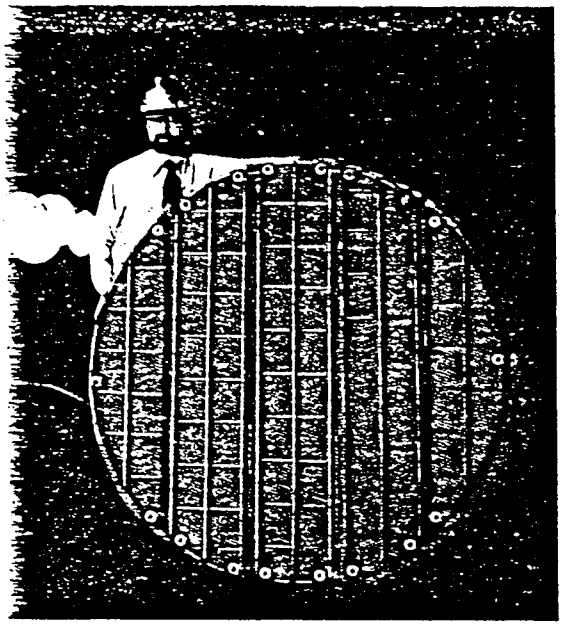
American Air Filter
AN ALLIS-CHALMERS COMPANY

Better Air is Our Business

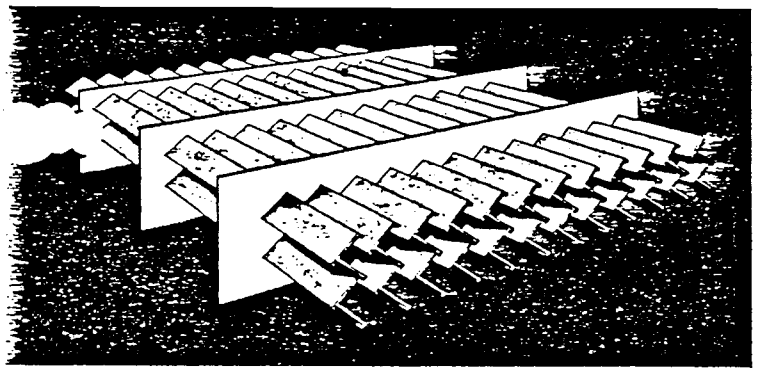
APPENDIX D-15

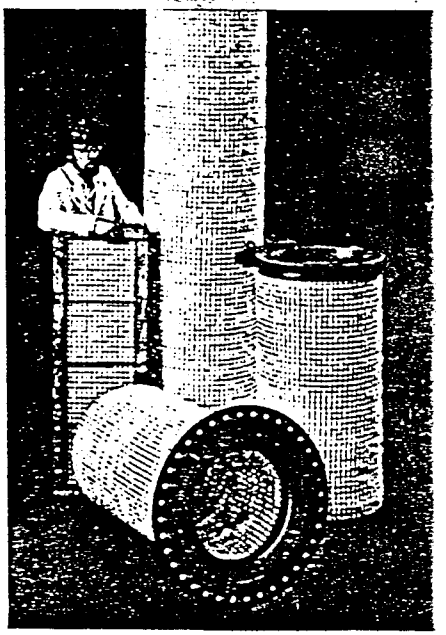
DEMISTER SPECIFICATIONS

WP# 9268A

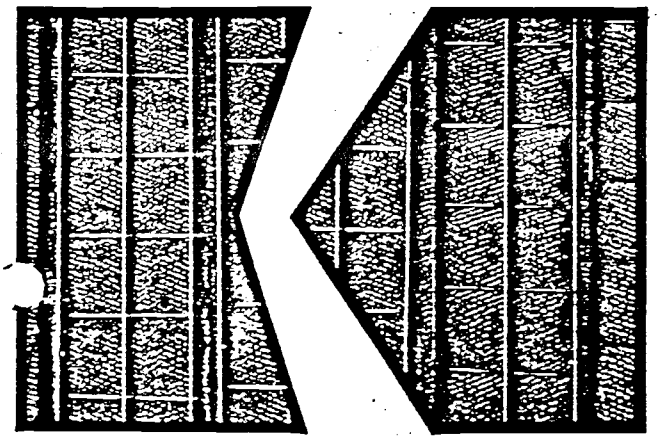


ONLY KOCH CAN FURNISH THE MIST ELIMINATOR THAT IS BEST FOR YOU...

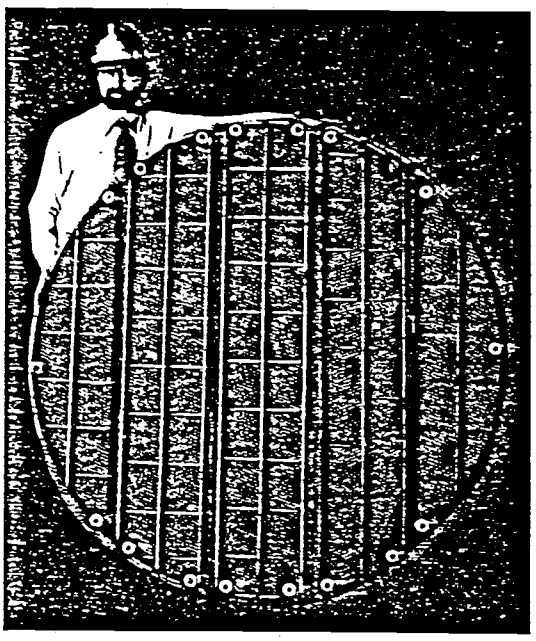




...NOT BEST FOR US!



Koch Engineering Company designs, manufactures and markets industry's most complete line of entrainment separators — FLEXIMESH, FLEXICHEVRON and FLEXIFIBER mist eliminators — in an array of styles, sizes and materials, to meet just about any requirement. Production plants are strategically located throughout this country and Canada to offer you the mist eliminator that is best for your processing operation. Other suppliers, because of limited line and facilities, must force fit a solution to many problems. If we don't have what you want "off-the-shelf", you can bet we'll custom build it speedily and at minimum cost.



KOCH FLEXIMESH® MIST ELIMINATORS

For Efficient Separation of . . . Mist And Liquid Entrainment From Gas And Vapor Streams.

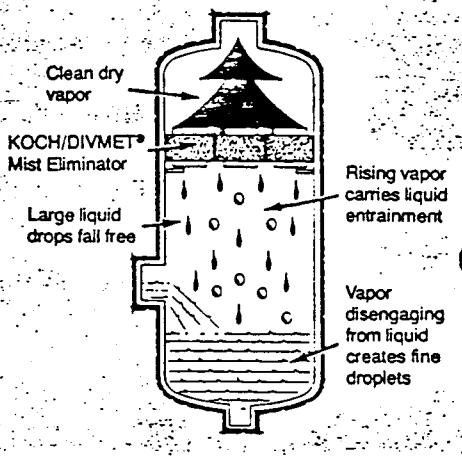
DIVMET DIVISION
(Formerly Diversified Metal Products, Inc.)

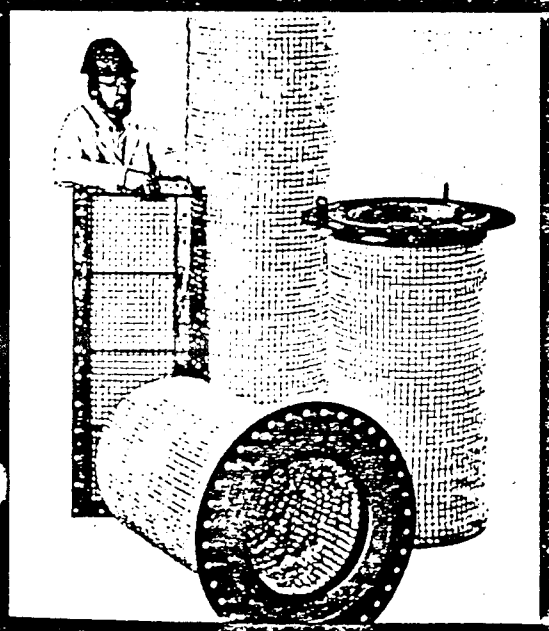
WHAT THEY ARE

FLEXIMESH/DIVMET mist eliminators are porous blankets of wire or plastic knitted mesh, designed and constructed for the efficient, economical removal of entrained liquid droplets from vapor streams. FLEXIMESH pads can be fabricated in any required size and shape and may be installed in new or existing process vessels. Normally installed so that vapor flow is upward through the mesh pad, other special installation methods can be used in unusual situations. FLEXIMESH separators can be furnished mounted on special lightweight, open-area support grids.

HOW IT WORKS

When vapor and entrained liquid droplets pass through a FLEXIMESH mist eliminator, the vapor moves freely through the mesh pad but the liquid droplets, due to their greater inertia, cannot make the necessary sharp turns and as a result are thrown into contact with the wire surfaces and briefly held there. As more droplets enter the pad and collect on the wires, they grow in size, run down the wire to the bottom surface of the mesh separator and fall from the unit. Overhead vapor is now free of entrained liquid.





KOCH FLEXIFIBER

Mist Eliminators . . . The Finer Fiber Bed To Stop Damaging Submicron Droplets And Fog

D-171

TYPES AVAILABLE

In small vessels where the top is removable, one-piece, wound units are used because of their lower cost. In larger equipment with access through a manway, or where a one-piece pad is not possible, sectional pads of FLEXIMESH are used. This type of construction is not limited as to size or shape. Units of up to fifty feet diameter have been produced as well as those of unusual shape. Mesh pad thickness is usually 4" or 6", but in some special circumstances could be as much as 24" or greater.

DATA REQUIRED

Proper design and selection of a FLEXIMESH separator can be assured by consulting our engineering department. Include the following information whenever possible:

1. Vapor velocity
2. Vapor density
3. Liquid density
4. Surface tension
5. Liquid viscosity
6. Operating pressure
7. Operating temperature
8. Process or system description
9. Materials of construction
10. Performance requirements

ALLOWABLE VELOCITY

Maximum allowable vapor velocity through FLEXIMESH mesh separators can be calculated using a complex equation which involves such factors as liquid viscosity, surface tension, droplet size and quantity of entrainment etc. as well as factors involving the vapor phase. To simplify the calculation, the equation below may be used with free-flowing systems to obtain an approximation of the optimum vapor velocity using only the actual vapor and liquid densities.

$$U = K\sqrt{\frac{\rho_L - \rho_V}{\rho_V}}$$

Where:

U = Allowable velocity (ft/sec)
K = System constant (usually 0.35)
ρ_L = Liquid density (lbs/ft 3)
ρ_V = Vapor density (lbs/ft 3)

STYLES AVAILABLE

Density			Surface Area				Mesh Styles					
lb/ft³	/	Kg/M³	FT²/FT³	/	M²/M³	% Voids	Koch/ Divmet	York	ACS	Old Koch	UOP Type	Stone & Webster
12.0	/	192	115	/	377	97.6	4120	—	4BA	1211	C	C
10.8	/	173	110	/	360	97.7	4210	421	—	—	—	—
10.0	/	160	163	/	535	94.0	3710	371	—	—	—	—
9.0	/	144	86	/	282	98.2	4310	431	4CA	911	A	B
8.0	/	128	140	/	459	98.4	3260	326	3BF	706	—	K
7.3	/	117	65	/	213	98.5	6440	644	—	—	—	—
7.0	/	112	65	/	213	98.6	5310	531	5CA	—	—	—
5.0	/	80	48	/	157	99.0	9310	931	7CA	511	B	A
20.0	/	320	450	/	1476	96.0	5520	—	—	—	—	L
27.0	/	432	610	/	2000	94.6	5540	333	—	—	—	P
4.0	/	64	125	/	410	97.0	2212	221	—	—	—	—
4.0	/	64	150	/	492	97.0	2414	241	—	—	—	—

WHAT IT DOES

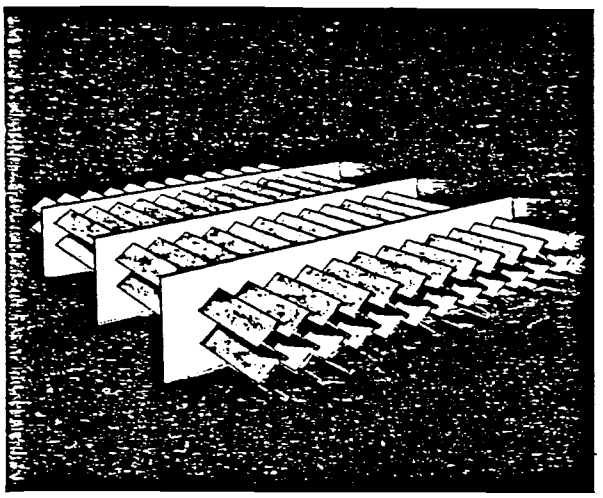
As FLEXIFIBER solves your pollution and process problems, it also provides other benefits. Our fiber beds recover raw materials and products that would otherwise go out the stack. A FLEXIFIBER Mist Eliminator removes pollutants that contaminate, foul and corrode plant equipment downstream, saving money in maintenance and equipment costs. FLEXIFIBER Mist Eliminators remove mists and fogs which cause explosions and other unsafe conditions. A FLEXIFIBER Mist Eliminator is often able to pay for itself in many applications.

HOW IT WORKS

FLEXIFIBER Mist Eliminators consist of special fine glass or other fibers densely packed between two corrosion resistant screens. As mist laden gas passes through the packed fiber bed, the random movement of submicron particles due to Brownian Diffusion forces the particles to come into contact with the fibers and be collected and coalesced into a liquid film. This film is then forced by the gas flow to the downstream side of the fiber bed where the liquid flows by gravity downward to the drain. For particles in the 1 to 3 micron range or larger, FLEXIFIBER uses the impaction mechanism for capture and collection.

COMPATIBILITY AND INTERCHANGEABILITY WITH OTHER MIST ELIMINATORS

FLEXIFIBER fiber bed mist eliminators are of modular design and come in a wide variety of types, sizes and materials. They are compatible and interchangeable with your present fiber bed mist eliminators. Koch custom designs each FLEXIFIBER installation to solve your particular mist problem.



1706-KE

KOCH FLEXICHEVRON® MIST ELIMINATORS

An Effective Droplet-Removal System For High Liquid Load And Fouling Applications.

WHAT IT IS

FLEXICHEVRON Mist Eliminators are a set of zig-zag baffles which are used to separate liquid droplets from flowing gases. The gases processed in this manner are suitable for atmospheric discharge or further processing.

WHERE THEY ARE USED

- All types of air pollution control scrubbing devices.
- Applications where droplets will be sticky or viscous and will plug knitted mesh mist eliminators. Evaporators in sugar and paper plants, refinery and petrochemical applications.
- Situations where wide flow rate ranges are possible and cyclonic-type mist eliminators will not be suitable.

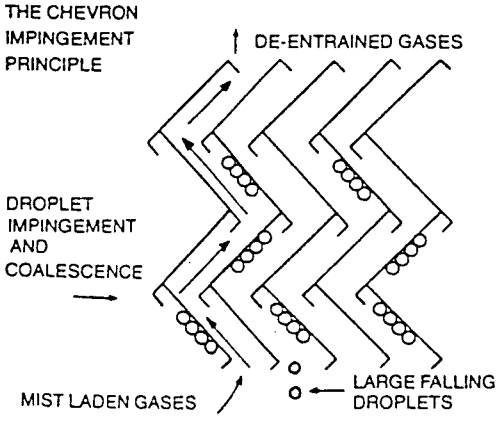
HOW THEY ARE SIZED

Sizing a FLEXICHEVRON Mist Eliminator involves a complicated relationship between gas velocity, gas density, liquid loading rate, droplet size, and liquid density.

Extensive pilot plant studies on the various FLEXICHEVRON styles, over a wide variety of conditions, permit Koch Engineers to select the correct type and size for your application.

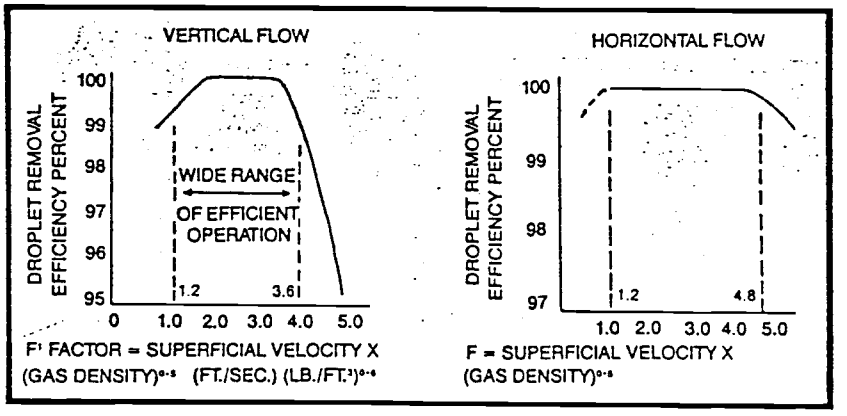
HOW THEY WORK

Gases with entrained liquid droplets flow between the zig-zag baffles. The gas can easily make the turns while the liquid droplets impinge upon the walls of the baffles and coalesce to a size such that they drop downward, being too heavy to be carried in the gas.



EFFICIENCY

Because it employs the impingement principle, the FLEXICHEVRON can be used efficiently over wide gas velocity ranges — without significant loss of droplet removal efficiency. Cyclonic-style mist eliminators (classically used as dust scrubbers) cannot operate efficiently over as wide a range of gas flows.



KOCH
KOCH ENGINEERING COMPANY INC.

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Los Angeles: 6880 Orangethorpe Ave. — Suite C, Buena Park, CA 90620, Telephone 714-739-8853
Canada: Muirhead Engineering Ltd., Sheppard Avenue East, Agincourt, Ontario, Telephone 416-293-3666
Europe: Koch International S.p.A., Casella Postale 13, 24061 Albano S. Alessandro, Bergamo, Italy
Koch International, GmbH, [illegible] 4000 Dusseldorf 1, West Germany

F-4c Water Supplies

The 1706-KE Waste Treatment System is not located in an area where water supplies could become contaminated from any route of exposure. Water supplies for the 100-K Area come from the Columbia River.

F-4d Equipment and Power Failure

Electrical power to the facilities at the 1706-KE Waste Treatment System is supplied by a 230 KV crosstie from the Hanford Loop. This power comes from the Bonneville Power Administration (BPA). Back-up power can be supplied from the K-N tie via a keylocked inner tie during an extended power outage.
A power failure at the 1706-KE Waste Treatment System will immediately sound an alarm in the 1706-KE Building.

F-4e Personnel Protection Equipment

The 1706-KE Waste Treatment Facility and the associated container storage area are located within radiation zones in the 1706-KE Building. All operations require that personnel use protective equipment such as gloves, shoe covers, and protective clothing. An emergency eyewash and a safety shower are provided in the 1706-KE Building.

F-5 PREVENTION OF REACTION OF IGNITABLE, REACTIVE, OR INCOMPATIBLE WASTES

No ignitable or reactive wastes are treated at the 1706-KE Waste Treatment Facility or stored in the container storage area.

In order to prevent reaction of incompatible wastes in the system, personnel at the facility check the 40 CFR 264 Appendix V Table, "Examples of Potentially Incompatible Wastes" prior to adding any new wastes to the system. Copies of this table are kept near all logbooks in the 1706-KE Building. In addition, during the hazardous waste training for the operators of the 1706-KE Waste Treatment System the operators will be given instruction concerning the limits and controls on the types of wastes which may be placed into the system. More information on this training is given in Section H of this application.

These internal communications systems provide an immediate link to other 1706-KE operations personnel and are capable of summoning emergency assistance.

F-3c Aisle Space

There is adequate space in the vicinity of the 1706-KE Waste Treatment System to provide for easy, unobstructed access to the facility by the fire department or other emergency responders.

The waste accumulation tank, ion exchange column, evaporation unit, condensor, condensate collection tank, and all associated piping are situated in the secondary containment system. There is a minimum of 36 inches of aisle space adjacent to the secondary containment areas.

The container storage area in the 1706-KE Building has a minimum of 36-inch aisle spacing. This aisle space is sufficient to allow unobstructed movement of personnel and equipment in the event of an emergency.

F-3d Arrangements with Local Authorities

DOE-RL has made arrangements with local authorities appropriate to the potential need for services from these authorities. Section G-6 of the Contingency Plan describes in detail these arrangements.

F-4 PREVENTIVE PROCEDURES, STRUCTURES, AND EQUIPMENT

F-4a Unloading Operations

This section is not applicable as the 1706-KE Waste Treatment System does not receive wastes other than those transported to the facility from the point of generation in the 1706-KE Building.

F-4b Run-Off

The 1706-KE Waste Treatment System and the associated container storage area are located completely within the 1706-KE Building. This building is totally enclosed and prevents precipitation from coming into contact with the wastes. No run-on is allowed to come into contact with the waste treatment system, and likewise, no run-off of precipitation occurs.

this facility. Emergency Response and cleanup functions are available for emergencies as described in Section G - Contingency Plan. A list of emergency equipment available on the Hanford Site is also available in Section G.

In the event that a fire occurs at the 1706-KE facility, personnel are instructed to contact the Building Emergency Director (BED) of the 1706-KE Building who will contact appropriate emergency personnel as outlined in Section G - Contingency Plan. The 1706-KE Waste Treatment System is equipped with fire control equipment including fire extinguishers and a supply of water to control small fires. Ignitable wastes are not treated in the system, so the chance of a large fire is remote.

The Hanford Fire Department has primary responsibility for spill response on the Hanford Site. While some equipment which could be used for immediate spill control is located in the 100-K Area, no equipment for spill response is located at the 1706-KE Waste Treatment System.

F-3a(4) Water for Fire Control

Water at adequate volumes and pressures to supply water hose streams and/or foam producing equipment for fire control will be supplied by the Hanford Fire Department for fires requiring high water volumes and pressure at the 1706-KE Waste Treatment System.

F-3b Access to Communications or Alarms

Personnel at the 1706-KE Waste Treatment System have immediate access to internal communications systems (telephones) which meet the requirements of WAC 173-303-320(2)(a) and (b) in the following situations:

(1) Whenever dangerous waste is being treated in the 1706-KE Waste Treatment System; and

(2) Whenever there is just one employee on the premises while the system is operating.

F-3 PREPAREDNESS AND PREVENTION REQUIREMENTS

The 1706-KE Waste Treatment System is designed, constructed, maintained, and operated to minimize the possibility of fire, explosion or any unplanned sudden or non-sudden release of dangerous waste or dangerous waste constituents to air, soil, or surface or ground water which could threaten the public health or the environment.

The following describes preparedness and preventive measures which help avoid or mitigate such situations.

F-3a Required Equipment

F-3a(1) Internal and External Communications

Operators at the 1706-KE Waste Treatment System have access to a telephone which is located approximately 50 feet from the system. This telephone allows both internal communication with others in the 1706-KE Building and external communications with others both on and off the Hanford Site.

Personnel can utilize the telephone to contact the Hanford Site Emergency System by dialing 811. This number provides direct contact with the Hanford Patrol, who will take appropriate emergency action.

Personnel in the 1706-KE Building also have the capability of summoning emergency assistance via a P.A. system. The P.A. system is capable of being heard above normal operations in all areas of the building. A facility fire alarm in the building is tied into the 100-K Area fire alarm for immediate summoning of fire control equipment and personnel.

F-3a(3) Emergency Equipment

All necessary emergency equipment is available for use at the 1706-KE Waste Treatment System. The Hanford Site maintains a large inventory of heavy equipment, hand tools, drums, and absorbent materials. The Hanford Site maintains a fire department capable of handling the worst scenario fire at

F-2c(2) Tank Monitoring Systems

The waste accumulation tank level sensor and the waste feed flowmeter will be inspected each operating day to ensure that this equipment is operating and that the system is being operated according to design.

The condensate collection tank level sensor will be inspected each operating day to ensure that the sensor is in place and operating according to design.

F-2c(3) Secondary Containment System

The secondary containment systems of the 1706-KE Waste Treatment System will be inspected each operating day to detect corrosion or any signs of a release of a hazardous waste into the secondary containment curb.

The presence of a released hazardous waste in the secondary containment system will warrant immediate (within 24 hours) action to remove the accumulated waste and to correct the problem(s) with the system.

F-2d Chemical, Physical, and Biological Treatment System Inspection Requirements

The ion exchange unit and the evaporation unit of the 1706-KE Waste Treatment System will be inspected each operating day. Any deterioration or malfunction will be remedied as soon as practicable to protect human health and the environment.

F-2d(1) Structual Integrity of Treatment Units

The ion exchange unit and the evaporation unit will be inspected each operating day for signs of corrosion or release of wastes from the units.

F-2d(2) Monitoring Equipment

All monitoring equipment, such as the waste feed cut-off systems, temperature controllers, pressure gauges, flowmeters, etc., will be inspected each operating day to ensure that they are in good working order and to ensure that the treatment units are operating as designed.

DATE: _____

TIME: _____

	STATUS		
	NO PROBLEMS NOTED	REQUIRED REMEDIAL ACTIONS/DATE	SEE COMMENTS
1. STRUCTURES			
A. CEMENT PAD	☐	☐ _____	☐
B. CURBING	☐	☐ _____	☐
C. DRAIN PLUGS IN PLACE	☐	☐ _____	☐
D. CONTAINMENT COATING INTACT	☐	☐ _____	☐
E. ROOF/WALLS	☐	☐ _____	☐
F. WARNING SIGNS	☐	☐ _____	☐
2. CONTAINER CONDITION			
A. CLOSED & SEALED	☐	☐ _____	☐
B. STRUCTURAL DEFECTS	☐	☐ _____	☐
C. CORROSION	☐	☐ _____	☐
D. LABELS	☐	☐ _____	☐
E. EVIDENCE OF LEAKAGE	☐	☐ _____	☐
3. SAFETY/EMERGENCY EQUIPMENT			
A. ABSORBENTS	☐	☐ _____	☐
B. EYEWASH	☐	☐ _____	☐
C. FIRE EXTINGUISHER	☐	☐ _____	☐
D. PROTECTIVE CLOTHING	☐	☐ _____	☐
E. GLOVES	☐	☐ _____	☐
F. OTHER	☐	☐ _____	☐

4. COMMENTS/CORRECTIVE ACTIONS

5. INSPECTOR SIGNATURE

(Print Name) _____

(Sign Name) _____

COPY 1 - 1706-KE BUILDING MANAGER COPY 2 - ENVIRONMENTAL PROTECTION GROUP *(RETAIN COPIES FOR THREE YEARS)*

2K8701-6.23

FIGURE F-2
1706-KE CONTAINER STORAGE AREA INSPECTION LOG

DATE: _____

TIME: _____

	STATUS		
	NO PROBLEMS NOTED	REQUIRED REMEDIAL ACTIONS/DATE	SEE COMMENTS
1. STRUCTURES			
A. CEMENT PAD	☐	☐ _____	☐
B. CURBING	☐	☐ _____	☐
C. DRAIN PLUGS IN PLACE	☐	☐ _____	☐
D. CONTAINMENT COATING INTACT	☐	☐ _____	☐
E. ROOF/WALLS	☐	☐ _____	☐
F. WARNING SIGNS	☐	☐ _____	☐
2. CONDITION OF TANKS AND TREATMENT SYSTEMS (ACCUMULATION TANK, CONDENSATE TANK, ION EXCHANGE UNIT, EVAPORATION UNIT)			
i. CLOSED	☐	☐ _____	☐
ii. STRUCTURAL DEFECTS	☐	☐ _____	☐
iii. CORROSION	☐	☐ _____	☐
iv. EVIDENCE OF LEAKAGE	☐	☐ _____	☐
3. MONITORING AND OPERATING EQUIPMENT (VALVES, PUMPS, PRESSURE GAUGES, LEVEL SENSORS, TEMPERATURE-SENSORS)			
A. STRUCTURAL DEFECTS	☐	☐ _____	☐
B. OPERATING CONDITION	☐	☐ _____	☐
C. CORROSION	☐	☐ _____	☐
D. EVIDENCE OF LEAKAGE	☐	☐ _____	☐
4. SAFETY/EMERGENCY EQUIPMENT			
A. ABSORBENTS	☐	☐ _____	☐
B. EYEWASH	☐	☐ _____	☐
C. FIRE EXTINGUISHER	☐	☐ _____	☐
D. PROTECTIVE CLOTHING	☐	☐ _____	☐
E. GLOVES	☐	☐ _____	☐
F. OTHER	☐	☐ _____	☐

5. COMMENTS/CORRECTIVE ACTIONS

6. INSPECTOR SIGNATURE

(Print Name) _____

(Sign Name) _____

COPY 1 - 1706-KE BUILDING MANAGER COPY 2 - ENVIRONMENTAL PROTECTION GROUP *(RETAIN COPIES FOR THREE YEARS)*

2K8701-6 24

FIGURE F-1
1706-KE WASTE TREATMENT SYSTEM INSPECTION LOG

F-2a(2) Inspection Log

Figures F-1 and F-2 are copies of the 1706-KE Waste Treatment System inspection logs. These logs will be filled out by the 1706-KE Building Manager or a designated alternate after each inspection. One copy will be retained in the 1706-KE Building in the office of the building manager, and one copy will be sent to the UNC Environmental Protection group each working day.

This log will contain the date and time of the inspection, the inspector's printed and handwritten signature, a notation of any observations made, and the date and nature of any repairs or other remedial actions.

F-2a(3) Retention of Records

Logs of facility inspections are kept for a minimum of 3 years following the inspection.

F-2b Container Inspection Requirements

The container storage area in the 1706-KE Building will be inspected on a weekly basis. The inspector will look for leaking containers and deterioration of the containment system caused by corrosion or any other factors. Remedial action will be taken if deterioration or leaks are detected.

F-2c Tank Inspection Requirements

F-2c(1) Structural Integrity of Tanks

The waste accumulation tank and the condensate collection tank of the 1706-KE Waste Treatment System will be inspected each working day. The inspector will look for signs of corrosion or release of wastes from the tank.

In addition, all tank ancillary equipment (valves, pumps, tubing, etc.) will also be inspected each working day for proper operation and for signs of corrosion or leaks.

TABLE F-1 (Continued)

Safety Shower / Eyewash - Ensure that these are in place and operational.

Signs - The warning sign on the entrance to the facility should be inspected for deterioration. This sign must be visible from 25 feet away.

TABLE F-1 (Continued)

SECONDARY CONTAINMENT

1706-KE Waste Treatment System (Daily) - Inspect the secondary containment of the 1706-KE Waste Treatment System daily to detect erosion or disrepair of the containment, and to detect any signs of a release of a hazardous waste.

Container Storage Area (Weekly) - Inspect the container storage area secondary containment weekly to check for deterioration of the containment system or the presence of released wastes in the containment.

The presence of liquids in the secondary containment system warrants immediate action to remove the liquids and correct any problems.

MONITORING SYSTEM AND OPERATING EQUIPMENT (Each Working Day)

Tank Level Sensors - Inspect the level sensors in the waste accumulation tank and the condensate collection tank to ensure that they are in place and are operational.

Flow Meter - Inspect the system flowmeter to ensure that it is in place and is operating.

Other Monitoring Equipment - Inspect the other monitoring equipment in the system, including the waste feed cut-off, the temperature controller, the pressure gauges, etc., to ensure that they are operating properly.

SAFETY AND EMERGENCY EQUIPMENT (Each Working Day)

Telephone - Ensure that the telephone near the waste treatment system in the building is operational.

Protective Clothing - Verify that protective clothing and gloves are stored at the waste treatment facility.

The building manager of the 1706-KE Building, or his designated alternate, is responsible for conducting the inspections of the 1706-KE Waste Treatment System and of the container storage area. The 1706-KE Waste Treatment System will be inspected according to the written schedule identified in this plan. A record of the inspection will be logged on an inspection form, as shown in Figure F-1. Personnel at the 1706-KE Building will retain the original of the inspection form, and a copy will be sent to the UNC Environmental Protection group. The inspection logs will be retained for a minimum period of three (3) years.

Any problems noted during the inspection will be brought to the attention of the 1706-KE Building Manager or his designated alternate as soon as possible after the inspection. Action to correct those problems will be undertaken as soon as is practicable. Any problems which pose an imminent threat to human health or the environment, as determined by the building manager, will receive immediate action to correct the problem.

If the inspection reveals the presence of any release of hazardous waste or accumulated liquid in the secondary containment system of either the waste accumulation tank or the condensate collection tank, action will be taken to remove the released materials and remedy any problems in the system within 24 hours.

This inspection plan and schedule will be kept in the office of the 1706-KE Building Manager. Another copy will be retained by the UNC Environmental Protection group. This plan will be reviewed and updated on at least a yearly basis or whenever changes have been made in the system. Any necessary changes to the plan will be made as soon as possible following the review.

F-2a(1) Types of Problems

The 1706-KE Waste Treatment System will be inspected for the types of problems noted in Table F-1. These potential problems are those which may cause or lead to a release of a radioactive mixed waste.

F-1b Warning Signs

The 1706-KE Waste Treatment System will be equipped with signs denoting the legend "Danger-Unauthorized Personnel Keep Out" at each entrance to the active portion of the facility. These signs will be legible from a distance of at least 25 feet. All signs will be posted in distinct locations around the facility and in sufficient numbers so that they can be seen from any approach route to the unit. All signs will be in English, the predominant language used in the area surrounding the facility.

F-1c Means to Control Entry

The 1706-KE Waste Treatment System is located within the Hanford Site Controlled Access Area. Access to the Hanford Area is controlled by the Hanford Patrol on a 24-hour per day basis.

In addition, the 1706-KE Waste Treatment System is located within the limited access area at the 100-K Area of the Hanford Site. Access to this limited area is controlled by a fence with a locked gate and a manned guard station. Unauthorized personnel are not allowed entrance into this area.

F-2 FACILITY INSPECTION PLAN

F-2a General Inspection Requirements

The 1706-KE Waste Treatment System will be inspected to prevent malfunctions and deterioration of the system, operator errors, or discharges which may cause or lead to the release of dangerous waste constituents to the environment or a threat to human health. These inspections will be conducted each operating day in order to identify problems in time to correct them before they can harm human health or the environment.

All monitoring equipment, safety and emergency equipment, security devices, and operating and structural equipment of the 1706-KE Waste Treatment will be inspected each operating day.

SECTION F
PROCEDURES TO PREVENT HAZARDS

F-1 SECURITY

The Department of Energy (DOE) Hanford Site maintains a site security program for the protection of government property, classified information, and special nuclear material. The security requirements of 40 CFR 264.14 and WAC 173-303-310 for hazardous waste treatment facilities are met by this security program. The security systems on the site prevent unknowing entry and minimize the possibility for unauthorized entry of persons or livestock into any of the hazardous waste facilities.

Unauthorized or unintended entry to hazardous waste facilities is prevented by (1) 24-hour surveillance systems in the form of manned barricades at the entries to controlled access areas, (2) fences, gates, locks, and warning signs, or (3) combinations of both (1) and (2). Only personnel who have been granted a security clearance from the U.S. Department of Energy (DOE) are permitted to enter the Hanford Controlled Access Areas. In addition, the Hanford Patrol provides surveillance patrols of the controlled access areas. Figure B-3 is a drawing illustrating some of the security measures related to the 1706-KE Waste Treatment System.

Site personnel receive training on Hanford Site security regulations in the form of required education and on-the-job training. Procedures for ensuring personnel compliance with security requirements, providing security education, and training personnel are developed and maintained on the Hanford Site. Performance of periodic security compliance audits and inspections ensure that procedures are followed.

F-1a Waiver

A Waiver of the security procedures and equipment requirements for the 1706-KE Waste Treatment System will not be pursued by the U.S. Department of Energy, Richland Operations Office (DOE-RL).

SECTION E
GROUNDWATER MONITORING

The 1706-KE Waste Treatment Facility, located in the 100-KE Area of the Hanford Site, is exempt from the groundwater monitoring requirements of WAC 173-303-645(1)(a) and 40 CFR 264.90(a) which state that ". . . the regulations in this subpart apply to owners and operators of facilities that treat, store, or dispose of hazardous waste in surface impoundments, waste piles, land treatment units, or landfills." The 1706-KE Waste Treatment Facility does not use any of the above land disposal units to manage hazardous wastes.

WP# 9134A

SECTION G
CONTINGENCY PLAN

The information contained herein is submitted in accordance with the requirements for a contingency plan, as contained in 40 CFR 270.14(b)(7) and 264 Subpart D and WAC 173-303-350 and -360. The intent of these regulations is to ensure that facilities which treat, store, or dispose of hazardous wastes have established the necessary planned procedures to follow if an emergency situation arises.

The 100 Areas Hazardous Materials/Waste Contingency Plan appears in Appendix G-1 and establishes policy and procedures for spill prevention, containment, and countermeasures to minimize any adverse impact to the environment, to reduce safety and health hazards, and to meet standards which define the acceptable management of hazardous waste. The standards in this plan apply to all areas of the facility that handle chemicals and treat, store, or dispose of hazardous waste. Information on the hazardous properties of the various chemicals used in the plant, the safeguards to protect personnel from exposure, and the proper handling, storage, and disposal of the hazardous materials is available onsite.

G-1 GENERAL INFORMATION

The 1706-KE Waste Treatment System is located near the 105-KE Reactor Building in the 100-KE Area and is used to store and treat laboratory generated dangerous wastes exhibiting hazardous characteristics by ion exchange and evaporation. Fires and liquid spills are potential hazards at this facility. The 1706-KE Waste Treatment facility is a staffed facility with a telephone and fire alarm system available for use by operating personnel.

The location of the 1706-KE Waste Treatment System is shown in Appendix B-2, the 100-KE Area Topographic map.

The contingency plan is designed to minimize hazards to human health and the environment from fires or any unplanned sudden or non-sudden release of hazardous waste or hazardous waste constituents to air, soil or surface water. The provisions of the plan will be carried out immediately whenever there is a fire or release of hazardous waste or hazardous waste constituents which could threaten human health or the environment.

This plan can be revised only by the Environmental Protection and Emergency Planning Groups based on information determined by these organization or on information made known by the manager(s) of the waste treatment system. Generally, the types of changes that warrant a revision are:

- Revision of the facility permit;
- An error(s) is found in the plan;
- In an emergency situation, the plan is found to be inadequate or incomplete;
- The facility manager changes;
- The emergency equipment list changes;
- The facility changes in such a manner that the plan is no longer correct or viable.

Copies of this plan are located at the 1706-KE Research Laboratories. Additional copies are located at the Patrol Operations Center (POC), with the UNC Emergency Planning Section (located in Building 1124-N in the 100-N Area), with the facility managers, with the Environmental Safety Staff, with the Area Emergency Director (AED), with DOE-RL, and with all groups that will be involved in emergency response.

G-2 EMERGENCY COORDINATORS

The overall responsibility for the protection of 1706-KE Waste Treatment System TSD facility personnel and property lies with the 100-KE Facilities Maintenance Manager. This person will identify Building Emergency Directors (BED) who are responsible for directing initial actions in the event of an emergency at the 1706-KE Waste Treatment facility. This responsibility includes the accountability of personnel at the event site, evacuation of the affected area, identification of material involved and safe shutdown of equipment and the waste treatment system. If an emergency occurs, the BED shall remain in charge with support provided by the Emergency Action Coordinator (EAC) and the Area Emergency Director (AED). The 1706-KE Waste Treatment System supervisor has been designated as the primary emergency coordinator (for the 1706-KE Waste Treatment System) from here on identified as the BED. The EAC or AED has the authority to commit all necessary resources including equipment and personnel in the case of emergency at the 1706-KE Waste Treatment Facility. The Emergency Action Coordinator is responsible for acting as the event site liaison between the AED, BED, and site emergency services.

The emergency chain of command for the TSD facility is shown below.

	Work Phone	Home Phone
Building Emergency Director (Primary Contact)		
1706-KE Facility - Ken C. Oberg	373-1589	943-4161
Area Emergency Director (Alternate Contact)		
100-KE Area - John F. Karns	373-3779	946-6496
Emergency Action Coordinator (Alternate Contact)		
1706-KE Facility - Blair B. Emory	373-1862	946-7184

The Building Emergency Directors are thoroughly familiar with all aspects of the contingency plan, all operations and activities at the 1706-KE Waste Treatment System Facility, the type and characteristics of the waste being treated, the location of all records and the layout of the 1706-KE Waste Treatment System.

G-3 IMPLEMENTATION OF THE CONTINGENCY PLAN

The decision by the BED to implement the facility plan depend on whether an actual incident such as a fire, chemical spill, or release of hazardous waste constituents threatens human health or the environment. Immediately after being notified of an emergency incident, the BED will proceed to the site and evaluate the situation. The following are situations that would warrant implementation of the contingency plan:

- o A fire occurs, such that
  - The potential for human injury exists
  - Toxic fumes are released
  - The fire could spread onsite or offsite and possibly ignite other flammable materials or cause heat-induced explosions
- o A spill or release of a hazardous material occurs such that
  - The spill can be contained onsite, but the potential exists for groundwater contamination
  - The spill cannot be contained onsite, resulting in offsite soil contamination and/or ground or surface water pollution

Many ways of discovering a spill or release of chemicals are available. This includes routine and scheduled inspections of areas by operating personnel.

Activation of the appropriate emergency organization is initiated by instrumentation and/or notification of the Patrol Operations Center (POC). Based upon the type and magnitude of the emergency event, the POC will notify the Hanford Fire Department Hazardous Materials Response Team.

Following discussions with the Building Emergency Director who has principal responsibility for stabilization and recovery, the Area Emergency Director and the UNC Management Representative shall agree upon preliminary subclassification for the event (see below) and determine the appropriate level of response. As additional information on the event becomes available, the Area Emergency Director and the UNC Management Representative shall revise the classification of the event and the response level accordingly.

The following excerpt from UNI-M-2 VOL1, The UNC Nuclear Industries Emergency Plan, lists the classifications of emergencies involving hazardous waste that can occur on the Hanford Site. The likelihood of an onsite hazardous waste emergency at the 1706-KE Waste Treatment System posing a health hazard to offsite personnel is remote, but is considered here as a "worst case" possibility.

Unusual Event

An unusual event that indicates a potential degradation of the level of safety or security of the plant. (Examples: fires, security threats, attempted entry or sabotage, natural disasters, minor explosions with limited impact, toxic or flammable gas release external to facilities, spill requiring evacuation of single building, etc.)

Alert

An event that involves one or more of the following:

1. Plant fatality
2. Serious injury
3. Actual or potential substantial degradation of the level of safety or security at the plant
4. Spill requiring evacuation of more than one building

The purpose of the alert is to assure that emergency personnel are available to readily respond if the situation becomes more serious, and to provide DOE-RL with current status information. This level of event involves

conditions where significant personnel contamination or exposure has or could occur. (Examples: loss of power resulting in containment compromise, severe natural phenomena, known explosive damage to facility, release of toxic or flammable gases into a facility, or events requiring evacuation of a plant facility.)

Site Emergency

An event that involves actual or likely major failures of plant safety/security functions needed for protection of the public and environs. A Site Emergency requires that onsite emergency response centers be activated and that DOE-RL make offsite notification to assure that all needed support centers are manned, assure that monitoring teams are dispatched, that personnel required for evacuation of near-site areas are at duty stations, and that information is provided to the public through offsite notifications. Such an event involves conditions where significant release of chemical wastes are likely to or are occurring and would cause exposure in the surrounding populace.

Hazardous material release onsite may exceed TLV and offsite is less than 1/10 TLV.

General Emergency

An event that involves actual or imminent substantial degradation of plant safety and/or security systems. The purpose of the General Emergency declaration is to initiate predetermined protective actions for the public, provide for continuous assessment of information, initiate any additional measures as indicated by actual or potential releases, provide for consultation with offsite authorities, and to provide information updates to the public through offsite authorities.

Hazardous material release onsite may exceed TLV STEL and offsite is greater than 1/10 TLV.

G-4 EMERGENCY RESPONSE PROCEDURES

G-4a Notification

Nonradioactive Dangerous Waste Treatment, Storage and Disposal Facilities

In the event of an emergency, the Building Emergency Director will be notified by the person discovering the problem. The BED will then notify the Patrol Operations Center (POC); subsequently, all personnel in the affected area; and appropriate federal, state, or local authorities (Section G-8) will also be notified. Figure G-1 depicts the chain of notification for an emergency at UNC Facilities.

The Patrol Operations Center (POC)

The Patrol Operations Center should consider notifying the following persons/groups in the event of a hazardous waste spill/incident:

- Patrol Management
- The Hanford Fire Department Hazardous Materials Response Team
- UNC Single Point of Contact (3-3333)
- DOE-RL Safety Duty Officer
- DOE-RL Security Duty Officer
- Pacific Northwest Labs (PNL) Exposure Evaluator

Building Emergency Director (BED)

The BED should consider the following actions in the event of a nonradioactive hazardous waste spill/incident:

- Evacuation of immediate area, if appropriate.

- Account for personnel known or thought to have been in facility. Report unaccounted for/missing personnel to the Area Emergency Director.

- Provide assistance to the Hazardous Materials Response Team and other outside support organizations as requested.

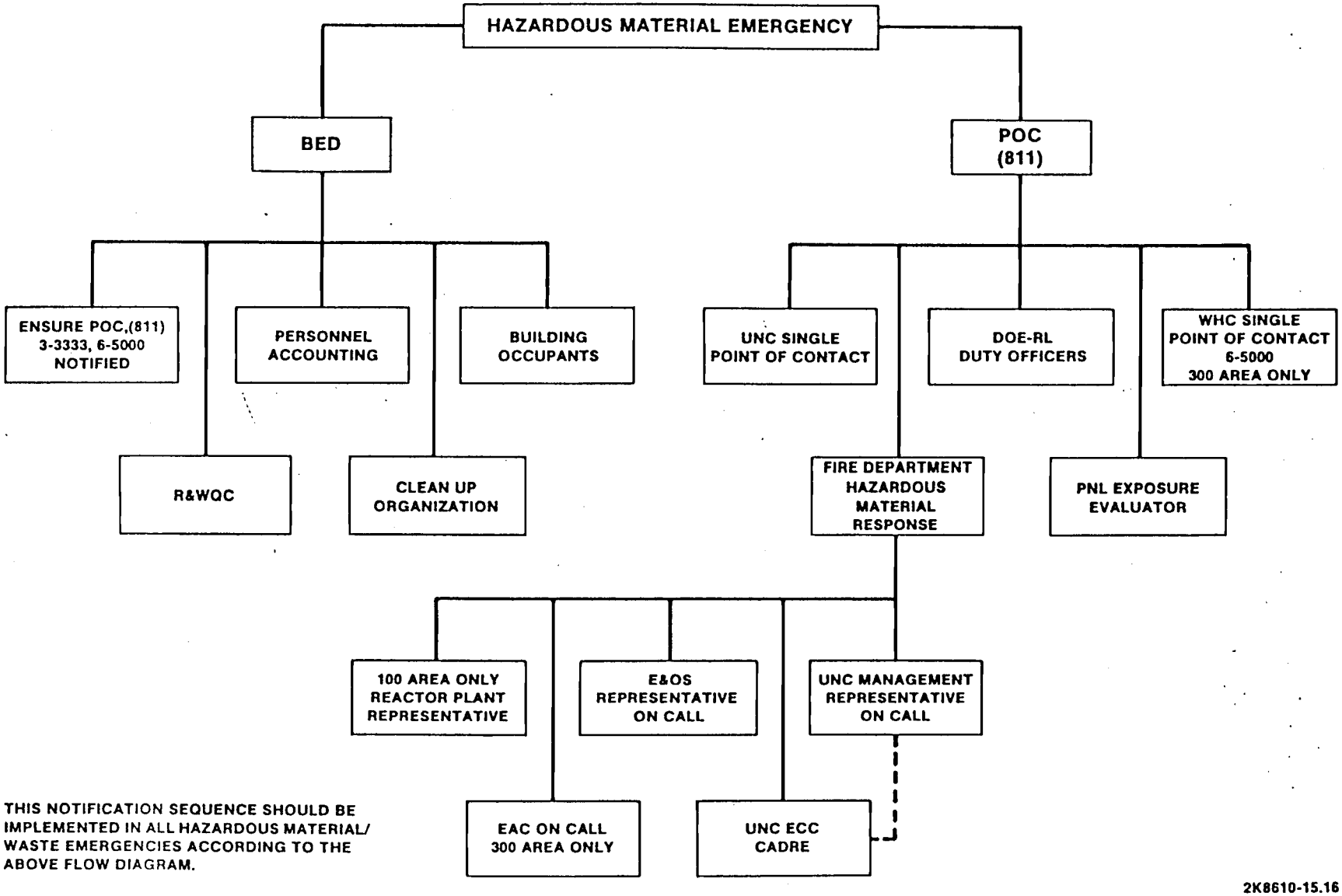

FIGURE G-1
HAZARDOUS WASTE EMERGENCY NOTIFICATION SEQUENCE

- For spills and discharges over the CERCLA/WDOE reportable quantity, contact the Environmental Protection Group, who will initiate notification procedures.

G-4b Identification of Dangerous Materials

The BED will immediately identify the character, exact source, amount, and areal extent of the release. Methods available for the identification of any spilled or discharged hazardous waste include notifying the PNL exposure evaluator who, if unable to identify the hazardous waste, has at his disposal any PNL personnel that he feels would be of assistance.

In addition, the following Environmental Protection staff may be contacted directly for expert environmental consultation during emergencies involving nonradioactive hazardous materials.

Name	Work Phone	Home Phone
B. L. Vedder	376-8903	946-1114
L. A. Garner	373-3639	946-2365
E. M. Greager	373-2245	586-9767

For assistance from the Hanford Environmental Health Foundation, the following may be contacted:

Environmental Health

Name	Work Phone	Home Phone
L. J. Maas	376-7040	586-0679
D. E. Anderson	376-7355	547-5118

Medical

Area	Phone Number
100	373-1603
200	373-2703
300/400 FFTF Areas	376-3303
700, 1100, 3000 Areas	376-6403

For assistance from DOE-RL, contact:

Name	Work Phone	Home Phone
P. J. Krupin	6-9989	783-0752

Identification of the spilled waste can be made by visual inspection, by sampling, and by reference to facility inventory records and shipping manifests. During 1986, several computer tracking systems and data bases were constructed to aid in hazardous waste identification. The BED for the facility will be aware of these computer systems and how to utilize them.

Standby service is also available from the Chemical Emergency Information Center (Chemtrec) by calling 1-800-424-9300.

G-4c Assessment

Once the spilled/ignited hazardous waste has been positively identified by the individuals listed in Section G-4b, it should be possible to determine the extent of the danger posed by the spill/fire. If the individuals present who performed the identification are uncertain of the danger, additional assessment aid can be obtained from the following sources:

The Hanford Fire Department Hazardous Material Response Team

The Chemtrec Information Center (1-800-424-9300)

The United States Department of Transportation Emergency Response Guidebook (DOT P 5800.3), copies of which are available from the Hazardous Materials Response Team, BEDs, EACs, and the Area Emergency Director

If consultation with the above sources does not result in a positive assessment of the danger to human health presented by the fire/spill, a worst case condition should be assumed and evacuation procedures should be initiated. Likewise, if a positive assessment of the spill/fire is made and a danger to human health is indicated, evacuation procedures should be initiated. The BED at the scene of the incident is responsible for initiating any evacuation.

Individuals performing a spill/fire assessment should keep in mind that it is necessary to assess both the direct and indirect hazards posed by the spill/fire.

G-4d Control Procedures

An overview of the emergency plan of action is outlined in Figure G-2. The 1706-KE Waste Treatment System is easily accessible by firefighting and other emergency equipment. The following actions will be taken in the event of a hazardous waste spill.

G-4d(1) Spill or Material Release

In the event of a major emergency involving a chemical or hazardous waste spill, the following general procedures will be followed for safe and rapid response and control of the situation:

1. The person who discovers the spill will immediately call the POC at 811 and contact the BED. Provide as much information as possible to the POC without personal risk. Calling the POC on 811 will cause the following individuals/organizations to be notified without any further action on the part of the caller; i.e., the POC will handle all notifications:

   Patrol Management
   The Hanford Fire Department Hazardous Materials Response Team
   UNC Area Emergency Director
   DOE-RL Safety Duty Officer
   DOE-RL Security Duty Officer
   Pacific Northwest Labs (PNL) Exposure Evaluator

2. The BED will proceed directly to the scene.

3. The BED will obtain all necessary information pertaining to the incident.

4. If evacuation is necessary, the AED will sound the evacuation alarm and give instructions over the PA system.

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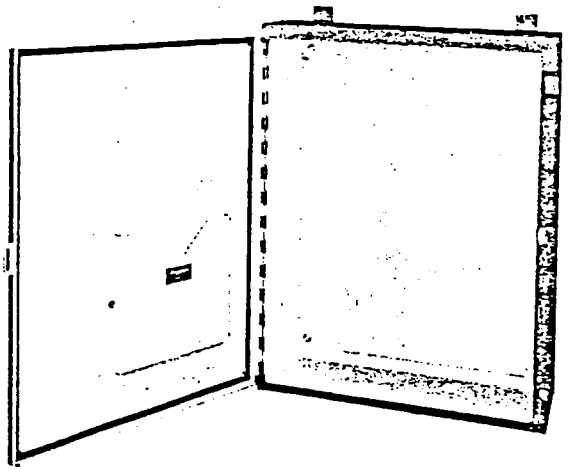
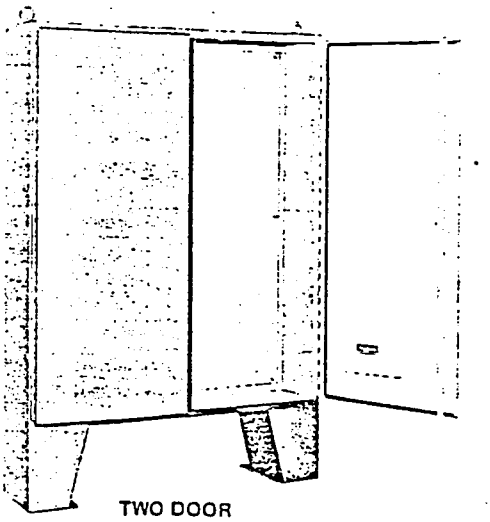
BULLETIN A-12
MARCH 1979

NEMA TYPE 12 ENCLOSURES



SINGLE DOOR



TWO DOOR

APPLICATION — Hoffman NEMA Type 12 Enclosures are designed to house electrical controls, terminals, and instruments. They provide protection from dust, dirt, oil, and water.

CONSTRUCTION —

SINGLE DOOR ENCLOSURES — Single door enclosures are made from 14 gauge steel and have a strong and rigid construction. All seams are continuously welded and there are no holes or knockouts. A rolled lip is provided around three sides of the door and around all sides of the enclosure opening; this increases strength and keeps dirt and liquids from dropping into the enclosure when the door is opened. The neoprene door gasket is attached with oil-resistant adhesive, and is also held in place with steel retaining strips. The door clamps are quick and easy to operate and have no loose parts. The door can be removed by pulling the hinge pin. A hasp and staple are provided for padlocking, and each enclosure has a removable and reversible print pocket. Only two small weldpins show on the inside of the door if the print pocket is removed. Body stiffeners and door stiffeners are provided in larger enclosures for extra rigidity. External feet are furnished for mounting. Collar studs are provided for mounting the optional panels. PANELS MUST BE ORDERED SEPARATELY.

TWO DOOR FLOOR-MOUNTED ENCLOSURES — Two door floor-mounted enclosures are made from 12 gauge steel, except for Cat. No. A-544208LP which is made from 14 gauge steel. All seams are continuously welded and there are no holes or knockouts. The neoprene door gaskets are attached with oil resistant adhesive, and are also held in place with steel retaining strips. These enclosures have uniquely gasketed, overlapping doors which eliminate the need for a center post. A 3-point latching mechanism, operated by an oil-tight key locking handle, holds the doors securely closed. There are rollers on the ends of the latch rods for easier door closing. Heavy-gauge continuous hinges support each door. Each enclosure has a removable print pocket, 12 inch floor stands, heavy-duty lifting eyes, and body stiffeners. Collar studs are provided for mounting the optional panels. PANELS MUST BE ORDERED SEPARATELY.

ACCESSORIES —

PANELS — Panels must be ordered separately, as they are not furnished with the enclosures. Panels for single door enclosures are 12 gauge steel. Panels for two door enclosures are 10 gauge steel, except for Cat. No. A-54P42 which is 12 gauge steel.

FLOOR STAND KITS — Floor stand kits in 6-inch, 12-inch, 18-inch, and 24-inch heights are available for factory or field installation on all single door NEMA 12 enclosures. See Bulletin A-80 for details.

TERMINAL KIT ASSEMBLIES — Bracket assemblies and terminal straps are available for mounting terminal blocks. See Bulletin A-80 for details.

DRIP SHIELD KITS — Drip shield kits protect the door and the door hardware from dripping water and settling dust. See Bulletin A-80 for details.

LATCH KITS & LOCK KIT — Latch kits with oil-tight key-locking handles are available for all single door NEMA 12 enclosures. An oil-tight lock kit is also available. See Bulletin A-80 for details.

ELECTRICAL INTERLOCKS — Hoffman electrical interlocks provide a positive internal safety lockout on electrical enclosures while the enclosure contents are energized. See Bulletin A-80 for details.

MISC. ACCESSORIES — Other accessories include oil-tight hole seals, touch-up paint, gasketed hubs, louver plate kits, window kits, rack angle kits, folding shelves, door stop kits, panel support kits, lock kits, and enclosure stabilizers. See Bulletin A-80 for details.

FINISH — The standard finish is white enamel inside and gray prime outside over phosphatized surfaces. Panels are white enamel.

MODIFICATIONS — Hoffman can supply holes, hubs, louvers, cutouts, special finishes, special materials, special enclosure sizes, and many other modifications. Be sure to specify if collar studs are required on special enclosures. Consult the factory for prices.

INDUSTRY STANDARDS — These enclosures conform to the National Electrical Manufacturers' Association (NEMA) standard for Type 12 (Industrial-use) enclosures. They also conform to Joint Industrial Council (JIC) Standard EGP-1-1967. Many of these enclosures are listed by Underwriters' Laboratories, Inc. as indicated in the table on the following page.

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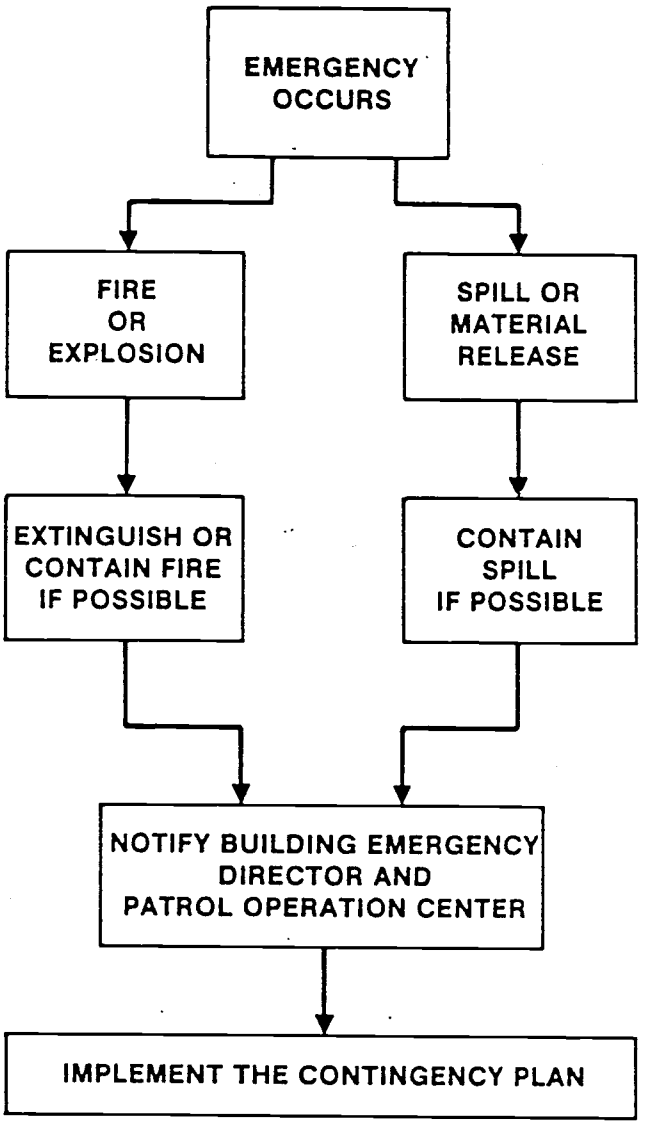

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FIGURE G-2
OVERVIEW OF THE EMERGENCY PLAN OF ACTION

5. The POC, while in contact with the AED, will contact and deploy the necessary off-plant personnel, such as the Fire and Security Department personnel.

6. The Security Department will set up roadblocks within the plant to route traffic away from the emergency scene.

7. The emergency medical technicians will remove injured personnel to a safe location, apply first aid, and prepare for transport to the Medical Department or Kadlec Hospital. A nurse will be on standby at the medical facility during the day shift.

8. The Hazardous Materials Response Team will contain the spill. If possible, vapors will be contained by vapor-suppressing foam. The Hazardous Materials Response Team will ensure that spilled material is properly collected and disposed of, and that no spilled material enters the storm drain system. These personnel will be equipped with proper protective equipment, such as Scott air paks.

9. The Hanford Fire Department Hazardous Materials Response Team will ensure that any flammable liquid spills do not ignite. In the event a fire results, the Hanford Fire Department will control the fire using water, foam and powders, as necessary.

10. All emergency equipment will be cleaned and fit for its intended use immediately after cleanup procedures are complete.

If the spill results in the formation of a toxic vapor that is released to the atmosphere, the plant-wide evacuation alarm will be sounded. Information on alarms and communication equipment can be found in Section G-5e.

G-4d(2) Fire or Explosion

The following actions will be taken in the event of a fire or explosion.

1. The discoverer of the fire should immediately extinguish the fire, with help from others, if it can be done safely.

2. If the fire cannot be safely and immediately controlled, the discoverer should activate the emergency alarm and then call the Patrol Operations Center (POC) at 811. Provide as much information as possible without personal risk. Calling the POC on 811 will cause the following individuals/organizations to be notified without any further action on the part of the caller, i.e., the POC will handle all notifications, as follows:

   - Patrol Management
   - The Hanford Fire Department Hazardous Materials Response Team
   - UNC Single Point of Contact (3-3333)
   - DOE-RL Safety Duty Officer
   - DOE-RL Security Duty Officer
   - Pacific Northwest Labs (PNL) Exposure Evaluator

3. Notify the BED, who will proceed directly to the scene.

4. Upon notification of emergency, all personnel will be evacuated away from the affected building.

5. The BEDs are responsible for accounting for all employees of their buildings.

6. If the emergency warrants, personnel will be evacuated from the 100-KE Area by emergency signals and voice announcements over the PAX from the 1722-K office.

7. The discoverer should immediately locate his BED and give details of the situation.

8. The Hanford Fire Department Hazardous Materials Response Team will immediately proceed to the affected area.

9. The BED and/or the discoverer of the fire will relay pertinent information to the Hanford Fire Department Hazardous Materials Response Team.

10. The Security Department will be responsible for setting up roadblocks within the plant and the emergency medical technicians (EMTs) for first aid assistance.

11. Under direction of the BED/EAC, the Fire Captain and the Fire Department will initiate actions necessary to control the fire.

12. The plant nurse will be contacted, and will man the emergency phone or report to the scene as required.

13. The EMTs will remove injured personnel to a safe location, apply first aid, and prepare for transport to the Medical Department or Kadlec Hospital.

14. The seriously injured will be transported to the plant medical facility or Kadlec Hospital for medical treatment.

15. After the fire or explosion has been extinguished and no threat to human health exists, the BED at the scene, with concurrence from the AED, will announce the "all clear" signal.

16. All equipment used in the emergency will be cleaned and fit for use after cleanup procedures are complete.

The initial response to any emergency will be to protect human health and safety and then the environment. Identification, containment, treatment, and disposal assessment will be secondary responses.

Stabilization of nonradioactive hazardous materials spill/incidents beyond the capacity of the facility personnel will be performed by the Hanford Fire Department Hazardous Materials Response Team. The Hanford Fire Department Hazardous Materials Response Team consists of four Hanford Fire Department personnel (one team leader and three fire fighters). Team members are trained to identify and control unplanned releases of hazardous materials, as practicable, using equipment specifically designed for hazardous material response. Upon arrival at the spill/incident scene, the Hazardous Material Response Team Leader will be briefed by the Fire Department officer-in-charge. The Hanford Fire Department officer-in-charge shall be the primary contact for all activities conducted at the scene during stabilizations. The Hanford Fire Department shall remain in a standby mode at the scene should assistance be required. Appendix F of the report located in Appendix G-1 describes training requirements for the Hazardous Materials Response Team.

The goals of the Hazardous Materials Response Team are to:

- Identify materials involved - Environmental and Occupational Safety (UNC) will be contacted to provide technical expertise on the incident material.

- Contain materials involved - Damming or diking of large spills will be accomplished with the use of available equipment.

- Neutralize materials involved - Applicable materials will be neutralized if it is necessary to expedite safe cleanup.

- Provide guidance for cleanup operations - Cleanup operations will be provided by the responsible facility personnel, if possible.

- Provide formal documentation of incident.

The following information should be considered by the EAC in the event of a hazardous material spill/incident.

Event	Event Categories	Action Options
Stress	Thermal, Mechanical, Chemical	Influence applied stress - move stressed system, shield stressed system, redirect impingement
Breach	Consumption (catastrophic, disintegration), cracking, punctures, splits, tears	Influence breach size - activate venting devices, chill contents, limit stress level
Release	Liquid or vaporous flow (steady, pulsating, diminishing)	Influence quantity size - change container position, minimize pressure differential, cap off breach
Engulfment	Hemispherical, spherical, conical, plume, circular, stream, irregular	Influence size of danger zone - erect dikes or barriers, dilute, initiate controlled ignition
Impingement	Transient, lingering, permanent	Influence exposures impinged - provide shielding, begin evacuation
Harm	Thermal, chemical, mechanical, asphyxiation, etiological	Influence severity of injury - rinse off contaminants, increase distance from source, provide shielding

G-4e Prevention of Recurrence

The BED/EAC is responsible for taking all necessary steps to ensure that a secondary release, fire, or explosion does not recur after the initial spill/leak incident. Procedures that will be implemented include:

- Immediate shutoff of flow or addition of waste into the waste treatment system;
- Inspection of the waste treatment system for leaks or cracks and stop the leak;
- Contain any surface leakage which has occurred;

- Isolation of residual waste materials and/or empty the waste treatment system if the leak cannot be stopped;

- Notification of the Department of Ecology in writing within 7 days after detecting the problem; and

- Reactivation of adjacent operations only after all cleanup of residual waste materials is achieved.

G-4f Storage and Treatment of Released Material

Immediately after an emergency, the BED (with support from the Hazardous Materials Response Team) will make arrangements for treatment, storage or disposal of recovered waste, surface water, or any other contaminated material. The BED will deploy and utilize any emergency equipment that he deems necessary to carry out these tasks.

The Environmental Protection Group is responsible for assuring that all cleanup materials/debris are properly identified according to WAC 173-303 dangerous waste designation procedures. This will occur as soon as possible once the emergency situation has ended to allow for proper treatment, storage or disposal of the material. The BED is responsible for obtaining all the necessary information required by the Environmental Protection Group to make a designation determination.

Wastes which are designated as "Extremely Hazardous Waste" or as "Dangerous Waste", will be transported to the appropriate waste storage facility and properly dispositioned. The UNC Radiological Services Group is responsible for disposal requests for all hazardous wastes generated at 100-KE Area.

Immediately upon scene stabilization, cleanup procedures will be implemented. These will include:

- Small spills will be treated with absorbent material and the residue packed in drums for disposal.

- All chemically contaminated equipment and debris will be thoroughly cleaned and contained for disposal.

- At all times, efforts will be made to segregate incompatible wastes during cleanup operations.

- The BED/EAC has the responsibility to make cleanup arrangements.

- The containment system evaluation and repair plan shall be activated.

The containment system evaluation and repair plan commences after the draining of the waste treatment system via visual inspection. Repair of any leaks shall be made as necessary. After proper repair, the waste treatment system will be filled with clean water and monitored for 12 hours for leaks. After verification that the leak has been repaired, the repairs will be certified by a qualified professional engineer as meeting the design specifications of the waste treatment system.

G-4g Incompatible Waste

Incompatible wastes are not treated in the 1706-KE Waste Treatment System. The BED at the scene will ensure that within the area affected by the spill/fire, no additional waste that may be incompatible with the released material is treated, stored or disposed of until all cleanup procedures are completed.

G-4h Post-Emergency Equipment Maintenance

All equipment used during scene stabilization and cleanup operations will be decontaminated and readied for future use. All persons involved in the cleanup will shower and remove any contaminated clothing as necessary. Fire extinguishers will be recharged and expended supplies will be replaced.

It will be the responsibility of the Building Emergency Director at the scene to ensure that all equipment is cleaned and fit for its intended use prior to the resumption of operations at the affected facility. Depleted stocks of

neutralizing laboratory materials will be replenished, self-contained breathing apparatus cleaned and refilled, protective clothing cleaned, etc. This action should be completed in total prior to the resumption of operations at the facility.

G-4i Container Spills and Leakage

There are limited containers at the TSD facility. Condensate tank water will be containerized in 55 gallon DOT Spec 17H drums in an adjacent room until analytical results verify that release parameters have been met (see Waste Analysis, Section C).

G-4j Tank Spills and Leakage

There are two tanks at the TSD facility, the 750 gallon waste storage tank and the 70 gallon process condensate tank. Procedures for the identification, hazard assessment, spill control, and treatment of spilled material and post-emergency cleanup of waste treatment system spills and leakage are contained in Section G-4b through G-4h.

G-4k Waste Pile Spills and Leakage

There are no waste piles at the TSD facility; therefore, this section is not applicable.

G-4l Surface Impoundments Spills and Leakage

There are no surface impoundments at the TSD facility; therefore, this section is not applicable.

G-4m Incineration Spills and Leakage

There are no incinerators at the TSD facility; therefore, this section is not applicable.

G-4n Land Treatment System

There are no land treatment systems at the TSD facility; therefore, this section is not applicable.

G-5 EMERGENCY EQUIPMENT

The locations of emergency equipment which can be utilized in the event of an emergency at the 1706-KE Waste Treatment System TSD facility are discussed in Appendix G-2. The locations of emergency services at Hanford are shown in Figure G-3.

G-6 COORDINATION AGREEMENTS

The presence of more than one DOE contractor on the Hanford Site allows for the mutual sharing of emergency equipment and personnel. All contractors have sufficient familiarity with the operations of each other to be of assistance with a minimum of direction. In addition to the emergency equipment, supplies and personnel described in Section G-5, the following services are on-call at the discretion of the Area Emergency Director or of DOE-RL.

Pacific Northwest Laboratory (PNL)

Single Point of Contact - The PNL Exposure Evaluator on 376-2222 fulfills the single point of contact role for PNL.

Atmospheric Sciences, Technical Support (373-2710 or 373-2716) - The PNL forecaster is available 24 hours a day and will provide, upon request, the current wind speed and direction at the accident site and indicate possible affected areas. The forecaster will also provide stability and mixing layer information upon request. The contractor who experienced the event is required to provide the location, the time, and the amount of chemical from the release. After receiving this information, the forecaster will call back within 15 minutes and give the event contractor's representative the following information:

- Estimated time of arrival of the plume at the affected areas.

- Estimated concentration of the affected areas, based upon normalized release rates and meteorological models (Mesoscale diffusion model).

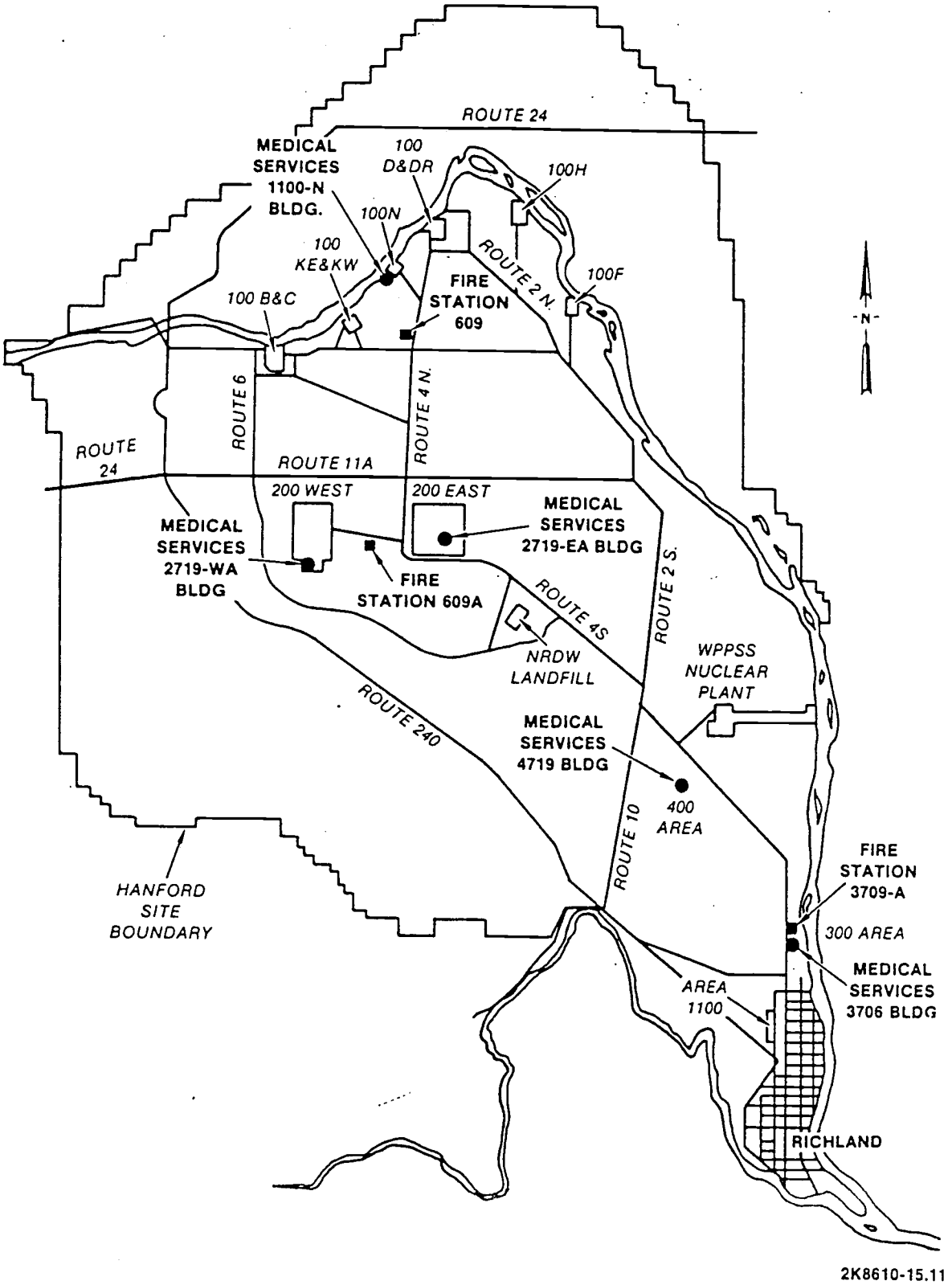

FIGURE G-3
EMERGENCY SERVICES LOCATIONS

The source of the release, the time of the release, the current and forecasted mixing level, and the stability information are put into the model, as well as the current and forecasted wind conditions. The output from this information is a series of maps showing contours of concentration. From these maps the direction of the plume is determined. This information will be updated at 30-minute intervals as long as it is needed.

Unified Dose Assessment Center (376-7365) - The Unified Dose Assessment Center (UDAC), which is located in the Federal Building, Room G-45, adjacent to the DOE-RL-ECC will be set up upon activation of the DOE-RL-EACT.

The primary purpose of the UDAC is to provide environmental and dosimetry evaluations and consultation services in the areas of industrial hygiene, biology, radiation monitoring, and meteorology.

The UDAC's responsibilities include:

1. Assessing the consequences of accidents or events on the Hanford Site having potential onsite and/or offsite consequences.

2. Making recommendations for coping with recovery from such an event.

The PNL maintains a staff of selected expert technical personnel to provide DOE-RL with advice on these matters.

Hanford Environmental Health Foundation (HEHF) (376-6414 Day or 373-1603 Night) The Hanford Environmental Health Foundation (HEHF) provides emergency medical and industrial hygiene services and maintains exposure histories for DOE-RL and the Hanford contractors. The HEHF emergency directors are responsible for coordinating these emergency actions and assuring that all necessary measures are employed by HEHF to handle medical and industrial hygiene services in emergency situations affecting Hanford. The HEHF will respond to requests for radiological assistance from offsite (local hospitals). The HEHF Procedures are contained in the HEHF Emergency Preparedness Guide.

Medical and administrative personnel are responsible for staffing the EDC and keeping it in a state of readiness for emergencies.

Kaiser Engineers - Hanford (KEH) (376-7297 Daytime, Home: A. L. Lindsey 627-1793)
The Hanford Site construction services contractor is Kaiser Engineers - Hanford (KEH). They maintain a large inventory of heavy equipment and trained equipment operators. Both equipment and personnel may be utilized in large-scale surface decontamination, emergency repairs in radiologically controlled areas, and in fire suppression support.

UNC Nuclear Industries (UNC)
Single Point of Contact - for UNC is 373-3333.

UNC maintains a single point of contact in the 105-N Control Room. This single point of contact has the ability to contact responsible personnel/organizations on a 24 hour/day, 7 day/week basis. Additionally, the 100-KE Shift Manager is the Area Emergency Director who provides continuous emergency service for the 100-KE Area in general.

Westinghouse Hanford Company (376-5000 Single point of contact)
The Westinghouse Hanford Company operates an ECC in Room B-2, 3701-D Building, 300 Area, in the 300 Area Patrol Headquarters. For further information, see WHC MG-30 Emergency Preparedness Guide, Emergency Facilities and Equipment.

U. S. Department of Energy - Richland Operations (373-3800 Single point of contact)
The DOE-RL Emergency Control Center is located in Room G-45, which is in the secured area of the Federal Building, Richland, Washington. The DOE-RL ECC is located in close proximity to the assigned staff personnel, the RL Communications Center, and additional office space.

The DOE-RL ECC is equipped with telephones, radios, emergency plans, maps, status board, and a 20-channel tape recorder. It is also equipped with an emergency power generator routinely serviced by GSA in the event of loss of primary power.

Kadlec Hospital (946-4611)

Kadlec Hospital is a fully equipped American Hospital Association Certified General Hospital that can treat both radioactive contaminated and noncontaminated cases. Kadlec has Emergency Room service with a Resident Physician available at all hours.

Emergency Decontamination Center (748 Building) (376-6292)

The Emergency Decontamination Center has the capability for body wash and has two decontamination surgical cells. The center also has special decontamination litter with hoist and monorail. The EDC, which is adjacent to the Kadlec Hospital in Richland, is available with unique equipment for performing surgery on severely contaminated injured persons. Hospital service is also available at Kadlec Hospital.

NOTE: Emergency power to the EDC will be supplied by a diesel generator provided to the facility by Rockwell Maintenance and Transportation Department. Requests for this equipment should be made to Rockwell via the Bus Dispatcher on 376-7266.

Other Organizations

The DOE-RL has formal agreements with Yakima Valley Memorial Hospital, Yakima, Washington; Kennewick General Hospital, Kennewick, Washington; and Our Lady of Lourdes Hospital, Pasco, Washington to provide backup medical assistance. The DOE-RL has a mutual aid agreement with the Washington Public Power Supply System (WPPSS) and the City of Richland for providing backup ambulance service. The City of Richland has mutual aid agreements with Pasco and Kennewick to provide additional ambulance, fire, and law enforcement services.

G-7 EVACUATION PLAN

Evacuation routes for the 1706-KE TSD facility have been mapped out and are shown in Figure G-4. Basically, the AED gives preliminary evacuation instructions to the Personnel Control Director (PCD) for facility personnel to proceed to one of the five alternate staging areas. Final evacuation and response instructions are then provided as to proper evacuation routes based on plume evaluation and weather data.

All UNC staff facilities have evacuation plans which include emergency signal identification, staging area location and, if required, plans for the use of the standby evacuation buses. This information can be found in UNI-M-2 VOL1 and VOL2 and excerpts are reproduced below.

Present Siren Coverage

Two siren signals are currently in use:

1. Steady sirens are activating to inform personnel that an alert/evacuation is occurring. People are required to meet at their assembly area(s) for instructions upon hearing the steady siren.

2. A wailing siren signal requires people to stay under cover. This siren may be used to protect personnel from radioactive fallout, hazardous material releases, adverse weather, etc.

Messenger/Mobile Contact

In the event the telephone communication systems fail, a mobile Patrol unit can be pressed into service to either deliver messages or establish radio contact with any building on the Hanford Site.

Staging Areas

The 1706-KE Waste Treatment System staging area is the same as for the 1706-KE Building and is located at the entrance to the 100-KE Area.

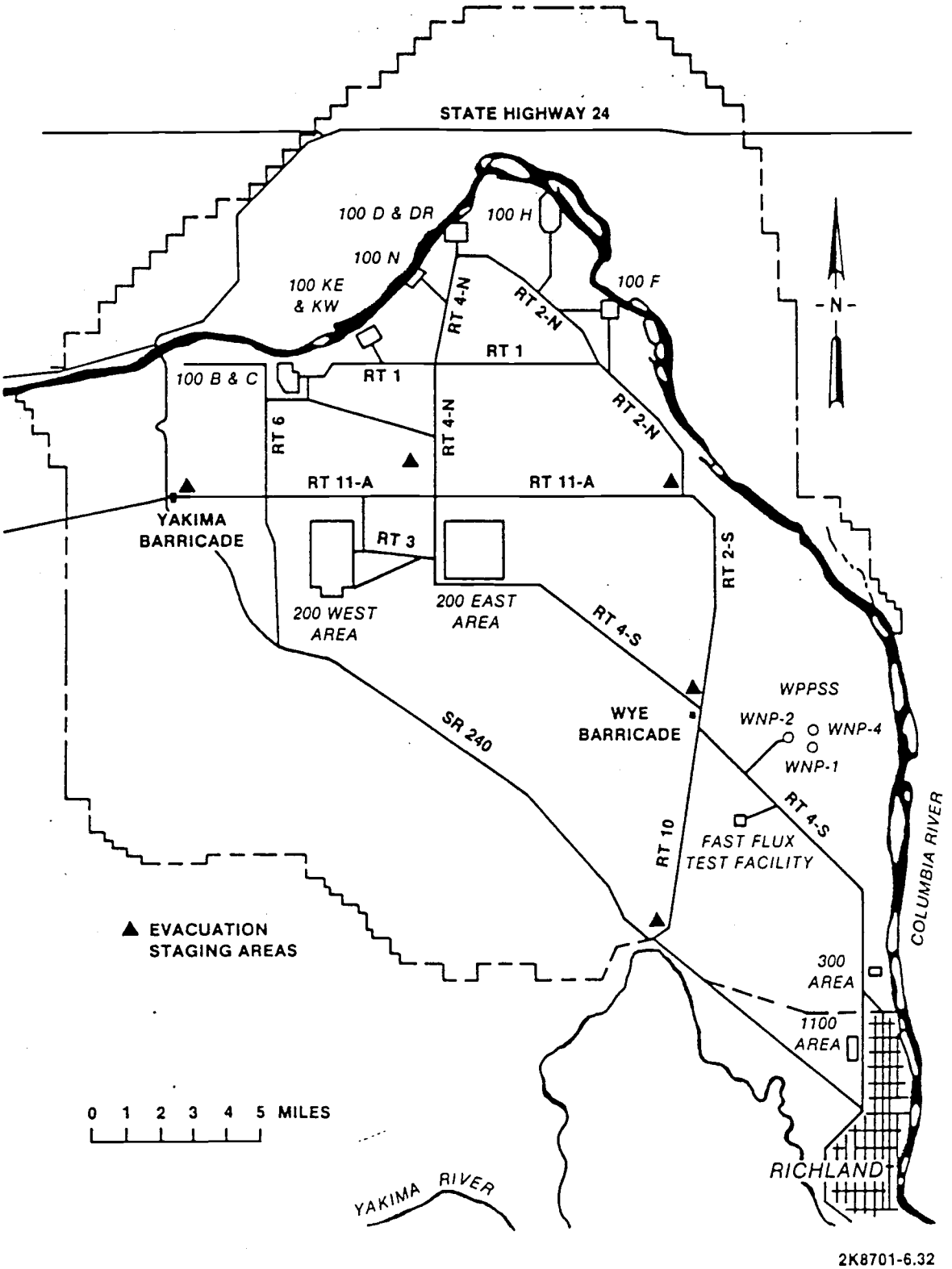

FIGURE G-4
EVACUATION ROUTES FOR THE HANFORD SITE

Evacuation Buses

Evacuation buses shall be provided to transport plant personnel away from work places under the following emergency conditions:

1. Local disasters such as a nuclear excursion where immediate, short transport distance is required.

2. Any disaster where movement of personnel away from the 100 Areas is required.

3. Enemy attack - take personnel to best available cover or transport to 1100 Area bus lot if time allows.

Responsibilities - Manager, K Area Operations. The Manager, K Area Operations, shall be responsible for assuring trained bus drivers are assigned sufficiently to move all buses on day shift and to move all employees on other shifts. A listing of qualified drivers shall be maintained, with their location, and forwarded to Emergency Planning annually.

Responsibilities - Bus Drivers. Bus drivers shall start and warm up their buses once each month; inspect bus for mechanical defects, complete a Monthly Inspection Report and forward it to Emergency Planning with a copy to the Manager, K Area Operations. Mechanical trouble shall be reported immediately to EP, telephone 373-2241. Buses needing cleaning shall be reported to Emergency Planning to schedule cleaning.

Each driver shall make a practice run two times per year to maintain familiarity with bus operation. Observe all traffic rules such as signals, stop signs, rail crossings, etc. during practice. Complete and submit a Monthly Inspection Report to Emergency Planning for filing. A file shall be kept for each bus.

Maintenance. Periodic cleaning and mechanical maintenance for evacuation buses at 1100 Area shops shall be provided by the Maintenance Department.

Location of Evacuation Buses. Buses are stationed at the 100-K limited area and main parking lot.

G-8 REQUIRED REPORTS

This section delineates UNC's statutory responsibility for the reporting of any hazardous waste incidents. UNC is aware of these reporting requirements and will prepare and submit the required reports.

Emergency incident reports will be submitted to appropriate state and federal agencies within 15 days of the occurrence of an emergency. The report shall include the following:

Name, address and phone number of the facility owner/operator

Name, address and phone number of the facility

Date, time and type of incident

Name of material(s) involved

Quantity of material(s) involved

Extent of injuries, if any

Assessment of actual or potential hazards to human health or the environment

Estimated quantity and disposition of material recovered from the incident

Records which identify the time, date and details of an emergency incident will be kept on file in the UNC Office of Emergency Planning in the files of the UNC Department responsible for the operation of the facility involved, and at the DOE-RL office in the Richland Federal Building. Additional copies would be made available to other interested parties.

49 CFR 171.15 Immediate Notice of Certain Hazardous Materials Incidents

a) At the earliest practicable moment, each carrier who transports hazardous materials (including hazardous wastes) shall give notice to DOE-RL (373-3800) in accordance with paragraph (b) of this section after each incident that occurs during the course of transportation (including loading, unloading and temporary storage) in which as a direct result of hazardous materials:

1. A person is killed.

2. A person received injuries requiring his hospitalization.

3. Estimated carrier or other property damage exceeds $50,000.

4. Fire, breakage, spillage, or suspected radioactive contamination occurs involving shipment or radioactive material (see also 174.45, 175.45, 176.48, 177.807 of this subchapter).

5. Fire, breakage, spillage, or suspected contamination occurs involving shipment of etiologic agents.

6. A situation exists of such a nature that, in the judgment of the carrier, it should be reported in accordance with paragraph (b) of this section, even though it does not meet the criteria of paragraph (a) (1), (2), or (3) of this section; e.g., a continuing danger of life exists at the scene of the incident.

b) Each notice required by paragraph (a) of this section shall be given to DOE-RL (373-3800) who will notify the Department of Transportation by telephone (toll-free) on 800-424-8802 or (toll call) on 202-426-2675. Notice involving etiologic agents may be given the Director, Center for Disease Control, U. S. Public Health Service, Atlanta, Georgia, Area Code (404) 633-5313, in place of the notice to the Department. Each notice must include the following information:

1. Name of reporter.

2. Name and address of carrier represented by reporter.

3. Phone number where reporter can be contacted.

4. Date, time and location of incident.

5. The extent of injuries, if any.

6. Classification, name and quantity of hazardous materials involved, if such information is available.

7. Type of incident and nature of hazardous material involvement and whether a continuing danger to life exists at the scene.

c) Each carrier making a report under this section shall also make the report required by 49 CFR 171.16.

WASHINGTON STATE ADMINISTRATIVE CODES

WAC 173-303-145 Spills and Discharges Into the Environment

Any person who is responsible for a nonpermitted spill or discharge shall immediately notify the individuals and authorities described for the following situations:

a) For spills or discharges onto the ground or into groundwater or surface water, notify all local authorities in accordance with the local emergency plan. If necessary, check with the local emergency service coordinator and the fire department to determine all notification responsibilities under the local emergency plan. Also notify DOE-RL (373-3800) who will contact the appropriate regional office of the Department of Ecology.

b) For spills or discharges which result in emissions to the air, notify all local authorities in accordance with the local emergency plan. If necessary, check with the local emergency service coordinator and the fire department to determine all notification responsibilities under the local emergency plan. Also notify DOE-RL (373-3800) who will contact the appropriate regional office of the Department of Ecology (Yakima - 575-2490).

CERCLA/WDOE NOTIFICATION PROCEDURES

In the event that a chemical release exceeds the CERCLA or WDOE reportable quantities (RQ) amount, data regarding the release will be compiled on the CERCLA/WDOE Hazardous Substance Release Report and Telephone notifications made within 24 hours of knowledge that a release has occurred. Contact the Environmental Protection Group (3-3639) if there is any question as to whether the release exceeds the RQ amount. The release report (Attachment B), will be prepared as follows:

- Copy information, if known, regarding substance name, composition, weight percent of constituents, and specific gravity or weight. Add other information that may be available to characterize the nature of the release.
- Enter name of facility and location of release.
- Enter quantity of release and exact point (e.g., tank number) of release.
- Enter cause (e.g., spill, overflow, pump leak).
- Enter time, date, and duration of release.
- Enter location that spill has drained to (e.g., floor of 1706-KE Building).
- Enter extent of injuries, damage, and approximate value of chemicals lost.

- Describe immediate corrective actions (e.g., lock and tag valve, repairs). Indicate whether an Off-Normal or Unusual Occurrence report is being initiated.

- Describe long-term actions that could or will be needed to prevent similar events in the future (e.g., procedural changes, equipment modifications).

- Provide name and telephone number of person delegated the responsibility to obtain and provide additional information that will be required.

- Plant Operations shall initiate telephone contact with the Department of Energy, Richland Operations Office (DOE-RL) SQA Duty Officer upon identification of the above information and record time and date of contact on the release report. Although the officer on duty and the telephone number changes weekly, the correct telephone number can be obtained from the Hanford Patrol Operations Center on 3-3800. The DOE-RL is responsible for contacting the National Response Center by telephone.

- Plant Operations shall initiate telephone contact with the following UNC personnel, and record time and date of contact on the release report.

Work Number	Home Phone	Name	Organization
3-2245	586-9767	E. M. Greager	Manager, Environmental Protection
----		----	Plant Manager, if applicable

- Transmit original copy of report to the Manager, Environmental Protection, 1145-N/100-N. The Environmental Protection Manager will submit written notification to DOE-RL within seven days of the release.

WP# 9141A

TABLE G-1

RADIO NETWORKS AND RADIO PAGING SYSTEM OPERATIONS

- Plant Radio Nets
  - Patrol - KKE624
  - Fire - KFW660
  - Transportation and Electrical Utilities - KRF249
  - Atmospheric Physics, Radiation Monitoring and 200 Area Maintenance - KGB513
  - DOE Alpha Net (controlled by DOC)
  - Hanford Emergency and Safety Net - KOB743

- Off-Plant Radio Nets
  - Washington State Patrol - KOA417
  - Benton County Sheriff - KON785
  - Richland Police - WOM20
  - Kennewick Police - KGX42

APPENDIX G-1

100 AREAS HAZARDOUS MATERIAL/WASTE CONTINGENCY PLAN

100 AREAS HAZARDOUS MATERIAL/WASTE CONTINGENCY PLAN

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100 AREAS HAZARDOUS MATERIAL/WASTE CONTINGENCY PLAN

INTRODUCTION

Hazardous materials are transported, used and stored in the 100 Areas of the Hanford Site. These materials are used to support nuclear production, waste processing, research and engineering programs, power generation and site services activities conducted within the Hanford Site. The type of hazardous materials required to support such diverse activities include explosives, compressed gases, flammable and combustible fluids, flammable solids, oxidizers and organic peroxides, toxic materials, reducing agents and corrosives. Shipments of these materials via truck and railcar have been made routinely in the past and will most likely continue well into the future. In the event of an unplanned release of these hazardous materials, a mechanism for prompt, orderly response must be in place to ensure minimal impact on personnel, property and the environment. In addition, hazardous wastes are stored and disposed of in the 100 Areas. The types of waste managed parallel hazardous materials used on the Hanford Site.

PURPOSE

The primary objective of this plan is to provide a series of response actions which will act to minimize the adverse effects of any hazardous material/waste that is accidentally released. Additionally, this plan identifies and describes supplemental information to support the primary objective as follows:

- Hazardous material storage locations
- Hazardous material transportation data
- Expertise contact list
- Response team equipment
- Response team training requirements
- Cleanup equipment
- Regulatory notification requirements

SCOPE

This plan provides primary coverage for all areas within the boundaries of the Hanford Site that do not have existing emergency plans for hazardous material/waste response. In addition, this plan provides supplemental coverage for plants and other locations that have existing response plans for handling hazardous material/waste emergencies.

This plan addresses response to hazardous nonradioactive material/waste and hazardous radioactive mixed waste emergencies only. Response to emergencies involving strictly radioactive materials is covered in other documents.

RESPONSIBILITIES

The Hanford Site Services Contractor is responsible for procuring, handling and transporting hazardous materials to Hanford Site customers. The charter for hazardous waste storage and disposal, fire suppression and rescue, law enforcement and traffic control is maintained by the site services contractor.

Specific responsibilities for emergency response within UNC/Rockwell are assigned as follows:

Activity	Responsible Organization
o Initial accident response	o Building occupants, Hanford Fire Department; Radiation and Water Quality Control (R&WQC)
o Scene stabilization	o Hanford Fire Department Hazardous Materials Response Team
o Technical expertise	o Environmental Protection
o Cleanup	o Building occupants, Rockwell/UNC Decontamination and Decommissioning (D&D) Operations Group, Road & Track Maintenance Department
o Scene Security	o Hanford Patrol

Supplemental coverage to plants by outside organizations (i.e., Hanford Fire Department Hazardous Material Response Team, D&D Operations, etc.) will be provided only when the plant Building Emergency Director (BED) has determined that the emergency exceeds existing plant response capabilities.

OTHER NOTIFICATIONS

State and federal law (Appendix C) requires that the Department of Energy, Richland Operations Office (DOE-RL) make the following notifications in the event of a spill/incident involving hazardous material/waste. Immediate notifications are as noted.

- For spills or discharges onto the ground or into ground water or surface water, and into the atmosphere (WAC 173-303-145):

  - Washington State Department of Ecology
    Industrial Selction
    Olympia, WA
    (206) 459-6031

  - U. S. EPA
    Emergency Response and Removal Section
    (206) 442-2163

- For spills or discharges occurring during transport (WAC 173-303-270):

  - Washington State Department of Ecology
    Industrial Section
    Olympia, WA
    (206) 459-6031

  - U. S. EPA
    Emergency Response and Removal Section
    (206) 442-2163

  - Generator of spilled material(s) (Immediate)

  - National Response Center, if required by Federal Regulation 49CFR 171.15 (Immediate)

    Phone: (800) 424-8802 or (202) 426-2675

- Also report in writing, as required by Federal Regulation 49CFR 171.16, to the:

  Director, Office of Hazardous Materials Regulations
  Materials Transport Bureau
  Department of Transportation
  Washington, D.C. 20590

- For any spills or discharges which occur within or pose a threat to a municipality:

  - City and county officials that may be affected (Immediate)

  - Above notifications, as applicable

Patrol Operations Center (POC)

The POC shall relay this information to:

- Area Emergency Director
- Patrol Management
- Hanford Fire Department Hazardous Materials Response Team
- Radiation and Water Quality Control (R&WQC)
- DOE-RL Safety Duty Officer
- DOE-RL Security Duty Officer
- PNL Exposure Evaluator

Building Emergency Director (BED)

The following actions should be considered in the event of a hazardous material/waste spill/incident:

[ ] Notify facility personnel.

[ ] Evacuate immediate area.

[ ] Call 811. Assure that Hanford Fire Department Hazardous Materials Response Team has been notified. Relay pertinent information. Request additional assistance as required.

[ ] Contact R&WQC if radiological hazards are involved.

[ ] Instruct plant personnel to carry out emergency/shutdown assignments as directed.

[ ] Account for facility personnel. Report unaccounted/missing personnel to the Area Emergency Director or 811.

[ ] Implement specific facility response actions as listed in the UNC Emergency Plan, UNI-M-2 VOLs 2-4.

[ ] Notify the Communications and Public Affairs and the affected Department managers.

[ ] Provide assistance to Hazardous Materials Response Team and other outside support organizations as requested.

[ ] For spills or discharges over the CERCLA/WDOE reportable quantity, contact Environmental Protection.

[ ] Notify cleanup organizations as required.

Hanford Fire Department

The Hanford Fire Department can supply a wide variety of equipment and trained personnel to support initial response efforts. The resources and capabilities of the Hanford Fire Department are listed in Appendix I. In the event that a spill/incident cannot be stabilized by the Hanford Fire Department, the officer-in-charge can request the Hazardous Materials Response Team.

Spill/incidents which involve mixed chemical and radiological hazards require the following supplemental information:

- In any situation where a high radiation field may be encountered and a Radiation Protection Technologist is not yet present, firefighters shall make initial precautionary radiation measurements using their HPCs (high-range survey instruments). The following limits apply:

  To save a life
  - 100 rem total individual dose
  - No pregnant females
  - Volunteers only

  To reduce a serious hazard that threatens worker or public health or large property loss
  - 25 rem total individual dose

  Generally, high radiation fields will not be encountered. However, measurements should be taken as a precaution for any incident involving a waste tank car or cask car from either the 100 Area or the 300 Area.

- The Radiation Protection Technologist(s) will set up the radiation/contamination control zone and will survey emergency personnel and equipment out of the zone. These actions will be coordinated through the Hanford Fire Department officer-in-charge at the scene.

- Clothing and equipment used by firefighters for protection against hazardous chemicals is also adequate for protection against airborne radioactive contamination.

Rockwell Utilities & Telecommunications/Utilities Maintenance

The Rockwell Utilities Maintenance Group is prepared to provide manpower, protective clothing, cleanup equipment and technical expertise in support of a spill/incident which involves Polychlorinated Biphenyls (PCBs). Table C lists points of contact for the Utilities & Maintenance Group.

SCENE STABILIZATION

Hazardous Materials Response Team

Stabilization of hazardous materials/waste spills/incidents beyond the capacity of the Hanford Fire Department will be performed by the Hazardous Materials Response Team. The Hanford Fire Department Hazardous Material Response Team will consist of four Fire Department personnel (one team leader and three firefighters). Team members are trained to identify and control unplanned releases of hazardous materials, as practicable, using equipment specifically designed for hazardous material response. Upon arrival at the spill/incident scene, the Hazardous Material Response Team leader will be briefed by the Hanford Fire Department officer-in-charge. The Hanford Fire Department officer-in-charge shall be the primary contact for all activities conducted at the scene during stabilizations. The Hanford Fire Department shall remain in a standby mode at the scene should assistance be required. Appendix A describes training requirements for the Hazardous Materials Response Team.

The goals of the Hazardous Materials Response Team are to:

- Identify materials involved - Environmental Protection will be contacted to provide technical expertise on the incident material.

- Contain materials involved - Damming or diking of large spills will be accomplished with the use of available equipment.

- Neutralize materials involved - Applicable materials will be neutralized if it is necessary to expedite safe cleanup.

- Provide guidance for cleanup operations - Cleanup operations will be provided by the Rockwell/UNC Decontamination and Decommissioning Operations Group and/or the Rockwell Road and Track Maintenance Department. Appendix B lists emergency equipment that will be available in a proposed Emergency Response Vehicle for use by the Hazardous Materials Response Team.

o Provide formal documentation of incident.

The following information should be considered in the event of a hazardous material/waste spill/incident.

Event	Event Categories	Action Options
Stress	Thermal, Mechanical, Chemical	Influence applied stresses - Move stressed system, shield stressed system, redirect impingement
Breach	Consumption (catastrophic, disintegration), cracking, punctures, splits, tears	Influence breach size - Activate venting devices, chill contents, limit stress level
Release	Liquid or vaporous flow (steady, pulsating, diminishing)	Influence quantity size - Change container position, minimize pressure differential, cap off breach
Engulfment	Hemispherical, spherical, conical, plume, circular, stream, irregular	Influence size of danger zone - Erect dikes or barriers, dilute, initiate controlled ignition
Impingement	Transient, lingering, permanent	Influence exposures impinged - Provide shielding, begin evacuation
Harm	Thermal, chemical, mechanical, asphyxiation, etiological	Influence severity of injury - Rinse off contaminants, increase distance from source, provide shielding

Upon completion of stabilization/neutralization activities, the Emergency Action Coordinator shall contact the cleanup organization assigned to the involved area for removal of contaminated soil and other materials.

CLEANUP PROCEDURES

Immediately upon scene stabilization, cleanup procedures will be implemented by the assigned organizations. These actions include the following:

- Small spills will be treated with absorbent material and the residue packed in drums for disposal.

- Leaking drums will be placed in overpack drums.

- All chemically contaminated soils and cleanup debris will be thoroughly cleaned up and contained for disposal.

- At all times, efforts will be made to segregate incompatible wastes during cleanup operations.

- All response equipment will be decontaminated, restocked or disposed of properly.

For Spills/Incidents in the 100 Area

The Rockwell/UNC Decontamination and Decommissioning Operations Group shall provide manpower and equipment for use in the cleanup of hazardous material/waste spills/incidents within the 100 Area. Requests for Rockwell/UNC Decontamination and Decommissioning Operations services can be made as follows:

- 373-4329

For Spills/Incidents Involving Polychlorinated Biphenyls (PCBs)

Special procedures, trained personnel and equipment are required for cleanup of a spill/incident which involves PCBs. The Rockwell Utilities Maintenance Group shall provide these services and can be contacted as follows:

- 373-2320 (24-hr dispatcher)

POST EMERGENCY PROCEDURES

Post-emergency procedures are designed to prevent recurrence of the incident, to facilitate cleanup and disposal of residuals, and chemical decontamination of equipment.

Prevention of Recurrence

The BED is responsible for taking all necessary steps to ensure that a secondary release, fire, or explosion does not recur after the initial spill/ incident. Procedures that will be implemented may include:

- o Inspection of containment for leaks or cracks
- o Inspection for gas generation
- o Isolation of residual waste materials
- o Reactivation of adjacent operations only after all cleanup of residual waste materials in achieved.

Treatment, Storage, or Disposal of Released Material

The Radiological Services group is responsible for assuring that all cleanup materials/debris is properly identified according to WAC 173-303 dangerous waste designation procedures. This will occur as soon as possible once the emergency situation has ended to allow for proper treatment, storage or disposal of the material. The BED is responsible for obtaining all the necessary information required by Radiological Services to make a designation determination.

Hazardous waste which are designated as "Extremely Hazardous Waste" or as "Dangerous Waste", will be transported to the Nonradioactive Dangerous Waste Storage Facility and properly dispositioned offsite to a commercial treatment or disposal site. The Rockwell Process Engineering Department is responsible for disposal requests for all hazardous wastes generated on the Hanford Site.

Equipment Chemical Decontamination and Maintenance

All equipment used during scene stabilization and cleanup operations will be decontaminated and readied for future use. All personnel involved in these activities will shower and remove any contaminated clothing as necessary. Fire extinguishers will be recharged, and equipment will be replaced.

TABLE A
BULK SHIPMENTS OF
NONRADIOACTIVE HAZARDOUS MATERIALS
ROUTINELY RECEIVED AT HANFORD SITE

Material	Delivery Rate	Amount per Delivery*	Transport
Ammonium Hydroxide	6/year	30 Tons	Truck
Chlorine	4/year	15 Tons	Truck
Helium	28/year	300,000 CFT	Rail
Morpholine	1/year	920 Lbs.	Truck
Sodium Hydroxide	14/year	47 Tons	Truck/Rail
Sulfuric Acid	10/year	50 Tons	Truck/Rail
#6 Fuel Oil	68/year	65,000 Gal.	Truck
Diesel Oil	20/year	24,000 Gal.	Truck

TABLE C
EXPERTISE CONTACT LIST

The following personnel may be contacted for expert consultation during emergencies involving hazardous materials:

UNC

Environmental Protection

Name	Work Phone	Home Phone
B. L. Vedder	376-8903	946-1114
L. A. Garner	373-3639	946-2365
E. M. Greager	373-2245	586-9767

Radiological Services

Name	Work Phone	Home Phone
J. R. Cooper	373-4939	1-452-6467
L. L. Crass	373-3127	946-0487

Polychlorinated Biphenyl (PCB) Assistance

Rockwell Electrical Dispatcher - 373-2320 (24-hours)

HANFORD ENVIRONMENTAL HEALTH FOUNDATION (HEHF)

Environmental Health

Name	Work Phone	Home Phone
L. J. Maas	376-7040	586-0697
D. E. Anderson	376-7355	547-5118

Medical

Area	Phone Number
100	373-1603
300 Area	376-3303

Department of Energy - Richland Operations

Name	Work Phone	Home Phone
P. J. Krupin	376-9989	783-0752
L. Musen	376-1610	783-5093
POC	373-3800	

Chemical Emergency Information - Chemtrec

(Toll Free) 1-800-424-9300

APPENDIX A
HAZARDOUS MATERIALS RESPONSE TEAM
TRAINING REQUIREMENTS

The following information outlines the training of the Hazardous Materials Response Team for the Hanford Site.

A. Team Concept

1. Two officers per shift to be trained as team leaders.

2. All shift personnel to receive training.

3. When incident occurs, the team leader will select the 3 firefighters to complete the Haz-Mat team.

B. Proposed Training

1. Standards: Orange County California Haz-Mat levels of training as a guide (after being reviewed).

2. EPA Hazardous Material response at Cincinnati, Ohio (7 personnel). (40 hours)

3. Haz-Mat hands on training onsite (40 hours). Same as command school.

4. Haz-Mat transportation emergencies onsite (40 hours). (Slide tape with workbooks.)

5. National Fire Academy, Hazardous Material Tactical Consideration (80 hours) at the fire academy (7 personnel).

6. Conduct two Haz-Mat drills per year - minimum.

7. Second year training to be reinforcing and update for selected personnel.

C. Training Cost

1. EPA Haz-Mat training - 40 hours. Class $770 + room and board - $4,500 + $6,500 overtime = $15,270.

2. Hands on training - 40 hours - $8,000.

3. Fire Academy - 7 personnel - 80 hours - Transportation and room and board - $8,000 + $10,000 overtime = $18,000.

APPENDIX B

CLEANUP SUPPORT EQUIPMENT

The following is a compilation of support equipment presently located at the Hanford Site that is available for use during a hazardous material/waste emergency at UNC facilities.

1. Rockwell/UNC Decontamination and Decommission Operations

   100 Areas

   55-Gallon Drums

   Sheet Plastic

   Dump Trucks

   Front Loaders

   Water Trucks

   Fabrifilm

2. Rockwell Road and Track Maintenance Department

   300 Area

   2 - 75-Ton Cranes

   3 - 14-Ton Cranes (self-propelled)

   2 - 5-Ton Cranes

   4 - Motor Patrol Blades

   4 - Tracked Dozers

   2 - Front Loaders

   1 - Tracked Loader

   2 - Water Trucks (5,000 gal)

   2 - Water Trucks (4,000 gal)

   2 - Backhoes

   5 - Dump Trucks (10 yd)

APPENDIX C

HAZARDOUS MATERIAL/WASTE NOTIFICATION REGULATIONS

WASHINGTON STATE ADMINISTRATIVE CODES

WAC 173-303-145 Spills and Discharges Into the Environment

(1) Purpose and Applicability

This section sets forth the requirements for any person responsible for a spill or discharge into the environment, except when such release is otherwise permitted under state or federal law. For the purpose of complying with this section, a transporter who spills or discharges dangerous waste or hazardous substances during transportation will be considered the responsible person. This section shall apply when any dangerous waste or hazardous substance is intentionally or accidentally spilled or discharged into the environment (unless otherwise permitted) such that public health or the environment are threatened, regardless of the quantity of dangerous waste or hazardous substance.

(2) Notification

Any person who is responsible for a nonpermitted spill or discharge shall immediately notify the individuals and authorities described for the following situations:

(a) For spills or discharges onto the ground or into groundwater or surface water, notify all local authorities in accordance with the local emergency plan. If necessary, check with the local emergency service coordinator and the fire department to determine all notification responsibilities under the local emergency plan. Also, notify the appropriate regional office of the department of ecology; and

(b) For spills or discharges which result in emissions to the air, notify all local authorities in accordance with the local emergency plan. If necessary, check with the local emergency service coordinator and the fire department to determine all notification responsibilities under the local emergency plan. Also, in western Washington notify the local air pollution control authority, or in eastern Washington notify the appropriate regional office of the department of ecology.

(3) Mitigation and Control

The person responsible for a nonpermitted spill or discharge shall take appropriate immediate action to protect human health and the environment (e.g., diking to prevent contamination of state waters, shutting of open valves).

(a) In addition, the department may require the person responsible for a spill or discharge to:

(i) Clean up all released dangerous wastes or hazardous substances, or to take such actions as may be required or approved by federal, state, or local officials acting within the scope of their official responsibilities. This may include complete or partial removal of released dangerous wastes or hazardous substances as may be justified by the nature of the released dangerous wastes or hazardous substances, the human and environmental circumstances of the incident, and protection required by the Water Pollution Control Act, chapter 90.48 RCW;

(ii) Designate and treat, store or dispose of all soils, waters or other materials contaminated by the spill or discharge in accordance with this chapter 173-303-WAC. The department may require testing in order to determine the amount or extent of contaminated materials, and the appropriate designation, treatment, storage, or disposal for any (substances) materials resulting from clean-up; and

(iii) If the property on which the spill or discharge occurred is not owned or controlled by the person responsible for the incident, restore the area impacted by the spill or discharge, and replenish resources (e.g., fish, plants) in a manner acceptable to the department.

(b) Where immediate removal or temporary storage of spilled or discharged dangerous wastes or hazardous substances is necessary to protect human health or the environment, the department may direct that removal be accomplished without a manifest, by transporters who do not have EPA/State identification numbers.

(4) Nothing in WAC 173-303-145 shall eliminate any obligations to comply with reporting requirements which may exist in a permit or under other state or federal regulations.

WAC 173-303-370 Discharges During Transport

In the event of a spill or discharge of dangerous waste during transportation, the transporter shall comply with the requirements of WAC 173-303-145, spills and discharges into the environment. In addition to the notices required by WAC 173-303-145, the transporter shall provide the following notifications:

(1) Give notice to the generator of the waste that a discharge has occurred;

(2) Give notice to the National Response Center (800-424-8802) or (202-426-2675), if required by 49 CFR 171.15;

(3) Report in writing as required by 49 CFR 171.16 to the Director, Office of Hazardous Materials Regulations, Materials Transportation Bureau, Department of Transportation, Washington, D.C., 20590; and,

(4) For a water (bulk shipment) transporter, give the same notice as required by 33 CFR 153.203 for oil and hazardous substances.

FEDERAL REGULATIONS (DEPARTMENT OF TRANSPORTATION)

49 CFR 171.15 Immediate Notice of Certain Hazardous Materials Incidents

(a) At the earliest practicable moment, each carrier who transports hazardous materials (including hazardous wastes) shall give notice in accordance with paragraph (b) of this section after each incident that occurs during the course of transportation (including loading, unloading and temporary storage) in which as a direct result of hazardous materials--

(1) A person is killed;

(2) A person received injuries requiring his hospitalization;

(3) Estimated carrier or other property damage exceeds $50,000;

(4) Fire, breakage, spillage, or suspected radioactive contamination occurs involving shipment or radioactive material (see also 174.45, 175.45, 176.48 and 177.807 of this subchapter); or

(5) Fire, breakage, spillage, or suspected contamination occurs involving shipment of etiologic agents; or

(6) A situation exists of such a nature that, in the judgment of the carrier, it should be reported in accordance with paragraph (b) of this section, even though it does not meet the criteria of paragraph (a) (1), (2), or (3) of this section; e.g., a continuing danger of life exists at the scene of the incident.

(b) Each notice required by paragraph (a) of this section shall be given to the Department by telephone (toll-free) on 800-424-8802 or (toll call) on 202-426-2675. Notice involving etiologic agents may be given the Director, Center for Disease Control, U. S. Public Health Service, Atlanta, Georgia, Area Code (404) 633-5313, in place of the notice to the Department. Each notice must include the following information:

(1) Name of reporter.
(2) Name and address of carrier represented by reporter.
(3) Phone number where reporter can be contacted.
(4) Date, time and location of incident.
(5) The extent of injuries, if any.
(6) Classification, name and quantity of hazardous materials involved, if such information is available.
(7) Type of incident and nature of hazardous material involvement and whether a continuing danger to life exists at the scene.

(c) Each carrier making a report under this section shall also make the report required by 171.16.

49 CFR 171.16 Detailed Hazardous Materials Incident Reports

(a) Each carrier who transports hazardous materials shall report in writing in duplicate on DOT Form F 5800.1 to the Department within 15 days of the date of discovery (including loading, unloading, or temporary storage) in which, as a direct result of the hazardous materials, any of the circumstances set forth in 171.15(a) occurs or there has been an unintentional release of hazardous materials from a package (including a tank) or any quantity of hazardous waste has been discharged during transportation. If a report pertains to a hazardous waste discharge--

(1) A copy of the hazardous waste manifest for the waste must be attached to the report, and

(2) An estimate of the quantity of the waste removed from the scene, the name and address of the facility to which it was taken, and the manner of disposition of any unremoved waste, must be entered in Part H of the report (Form F5800.1).

(b) Each carrier making a report under this section shall send that report to the Information Systems Manager, Materials Transportation Bureau, Department of Transportation, Washington, D.C. 20590.

(c) Except as provided in paragraph (d) of this section, the requirements of paragraph (a) of this section do not apply to incidents involving the unintentional release of hazardous materials being transported under the following proper shipping names:

(1) Consumer commodity
(2) Battery, ELECTRIC STORAGE, wet, filled with acid or alkali
(3) Paint, Enamel, Lacquer, Stain, Shellac or Varnish Aluminum, Bronze, Gold, Wood filler, liquid or Lacquer-base liquid when shipped in packages of five gallons or less

(d) The exceptions to incident reporting provided in paragraph (c) of this section do not apply to:

(1) Incidents required to reported under 171.15(a).
(2) Incidents involving transportation aboard aircraft.
(3) Incidents involving the transportation of hazardous waste.

DEPARTMENT OF TRANSPORTATION (DOT) FORM F 5800.1

(See following pages C-5 and C-6).

APPENDIX D

CERCLA/WDOE NOTIFICATION PROCEDURES

In the event that a chemical release exceed the CERCLA or WDOE reportable quantities (RQ) amount, data regarding the release will be compiled on the CERCLA/WDOE Hazardous Substance Release Report and telephone notifications made within 24 hours of knowledge that a release has occurred. Contact Environmental Protection if there is any question as to whether the release exceeds the RQ amount. The release report will be prepared as follows:

- Copy information, if known, regarding substance name, composition, weight percent of constituents, and specific gravity or weight. Add other information that may be available to characterize the nature of the release.
- Enter name of facility and location of release.
- Enter quantity of release and exact point (e.g., tank number) of release.
- Enter cause (e.g., spill, overflow, pump leak).
- Enter time, date, and duration of release.
- Enter location that spill has drained to (e.g., 163-N, 1324-NA).
- Enter extent of injuries, damage, and approximate value of chemicals lost.
- Describe immediate corrective actions (e.g., lock and tag valve, repairs). Indicate whether a Process Standard Violation or Plant Event report is being initiated.
- Describe long-term actions that could or will be needed to prevent similar events in the future (e.g., procedural changes, equipment modifications).
- Provide name and telephone number of person delegated the responsibility to obtain and provide additional information that will be required.
- Plant Operations shall initiate telephone contact with the Department of Energy, Richland Operations Office (DOE-RL) SQA Duty Officer immediately upon identification of the above information, and record time and date of contact on the release report. Although the officer on duty and the telephone number changes weekly, the correct telephone number can be obtained from the Hanford Patrol Operations Center on 3-3800. The DOE-RL is responsible for contacting the National Response Center by telephone within 24 hours.

APPENDIX G-2
EMERGENCY EQUIPMENT

APPENDIX G-2
EMERGENCY EQUIPMENT

G-2a Hanford Fire Department

The following is a description of equipment presently available from the Hanford Fire Department, which could be used in a nonradioactive hazardous materials incident.

Telesqurts - Located at 609, 609-A and 3709-A Fire Stations

The Hanford Fire Department presently has three Telesqurt trucks. Each Telesqurt has the capability to pump 1500 gpm of water with a 50-foot boom. A limited amount of rescue equipment is carried on board each truck, including SCBA units for the firefighting crew.

MX-3 - Located at 3709-A Fire Station

The MX-3 is a multichemical truck designed to combat metal-type fires such as sodium and lithium. Each dry chemical agent is carried on board in a separate container. Stored in the first container is 100 pounds of NaX extinguishing powder for use on sodium fires. The second container holds 500 pounds of micro-spheroids for use on lithium fires. Each of these containers is automatically pressurized and activated from the truck cab. Two SCBA units and two metal fire protective suits are located on board the truck.

Attack 1 - Located at 609-A Fire Station

Attack 1 is a four-wheel-drive, triple combination truck capable of off-road travel. This unit carries 450 lbs of Purple K dry powder extinguishment, 300 gallons of 3% AFFF concentrate foam, 300 gallons of 3% AFFF premix foam, and 300 pounds of 1211 Halon suppressant. All three agents are dispersed through 150 feet of booster-type hose designed for each particular agent. The AFFF premix solution can also be dispersed from a rooftop turret nozzle. Two SCBA units, a 4kW diesel generator and various small tools are also stored on this truck.

Squad 3 - Located at 3709-A Fire Station

Squad 3 is a van-type vehicle containing various light duty to heavy duty tools and equipment including:

- o Acetylene torch
- o 4kW generator
- o Block and tackle sets
- o Chlorine patch kit
- o Emergency lighting

Rescue Trailer - Located at 609 Fire Station

This trailer is a four-ton model containing miscellaneous rescue equipment which includes:

- o Block and tackle sets
- o Light to heavy duty ropes
- o Hand and power tools
- o 6kW gasoline generator

G-2b Cleanup Support Equipment

The following is a compilation of support equipment presently located at the Hanford Site that is available for use during a nonradioactive hazardous material emergency:

1. Rockwell/UNC Decontamination and Decommission Operations

   200 Areas

   55-gallon drums

   Sheet plastic

   Dump trucks

   Front loaders

   Water trucks

   Fabrifilm

2. Rockwell Road and Track Maintenance Department

1100/600 Areas	200/600 Areas
2 - 75-Ton Cranes	1 - 60-Ton Crane
3 - 14-Ton Cranes (self-propelled)	1 - 40-Ton Crane
2 - 5-Ton Cranes	1 - 25-Ton Crane
4 - Motor Patrol Blades	3 - Motor Patrol Blades
4 - Tracked Dozers	12 - Tracked Dozers
2 - Front Loaders	5 - Scrapers
1 - Tracked Loader	3 - Front Loaders
2 - Water Trucks (5000 gal)	1 - Water Wagon (9000 gal)
2 - Water Trucks (4000 gal)	1 - Water Wagon (8000 gal)
2 - Backhoes	1 - Water Truck (4000 gal)
5 - Dump Trucks (10 yd)	1 - Water Truck (2500 gal)
	1 - Backhoe

G-2c Emergency Medical Equipment, Facilities and Personnel

Hanford Environmental Health Foundation maintains its own occupational medical staff which provides onsite medical assistance in the worksite environment. Additional emergency medical service is provided as needed.

100-N Medical Aid Station (811)

1 - Registered Nurse (RN) certified as emergency medical technician (EMT), available 24 hours per day, 7 days per week

1 - Bed

1 - Portable O_2 unit

1 - Life Pak 5 (life support equipment)

1 - Ambulance equipped for life support services (ambulances are located at area fire stations)

1 - Standby ambulance

1 - Completely equipped Medical Aid Station

1 - Portable two-way radio on Patrol and Fire Frequency

300 Area Medical Aid Station (376-3303) (811)

2 - RNs with EMT certification on duty, one from 7:00 a.m. to 3:00 p.m. and one RN from 3:30 a.m. to 11:50 p.m., Monday through Friday

1 - Bed

1 - Portable O_2 unit

1 - Life Pak 5

1 - Ambulance equipped for life support services (ambulances are located at area fire stations)

1 - Standby ambulance

1 - Completely equipped Medical Aid Station

1 - Portable two-way radio on Patrol and Fire Frequency

G-2d Emergency Communication System

Responsibility and Use of 811

The 811 emergency notification system provides a uniform and easy-to-remember mechanism for activating emergency response measures and providing accurate and timely communication to top management of unplanned incidents. UNC employees and managers are expected to use the 811 system for immediate notification of incidents that impact (or potentially impact) the safety of personnel, the environment, or the continuity of plant operations. Examples, but not necessarily an inclusive list, follow:

- Bomb threats
- Explosions
- Fires
- Injury or serious illness
- Security violations
- Vehicle accidents
- Failure of emergency equipment or safety systems
- Incidents requiring facility evacuation or curtailment of major facility operations
- Power outages or other utility disruptions
- Major equipment or facility damage
- Flooding
- Natural disasters

- Occurrences involving hazardous materials
- Other accidents or incidents impacting, or potentially impacting, plant operations or personnel

Should there be a doubt whether an incident warrants an 811 call, always error in favor of the call - Call 811.

Commercial Telephone Systems

The Hanford Site commercial telephone system is a model GTD 4600, all digital system with programmable features. The system currently has 3800 line capacity with 260 trunks in use. The Rockwell Telecommunications department provides the interface between the site contractors and the commercial telephone company.

Radio (UHF and VHF)

The radio communication network is extensive at Hanford. The various emergency response groups, type of radio and call signs are listed in Table G-1. Table G-1 gives frequency, call signs and station assignments.

Radio Paging System Operation

A new radio paging terminal has been installed at Hanford and, eventually, all pagers will be transferred to the new terminal. During the interim, the

pagers will continue on the old paging terminal until they are individually transferred to the new terminal. The old terminal will continue to operate in the same manner until all pagers have been removed.

The following describes the method of accessing and using the new paging terminal: (NOTE: The new paging terminal is accessed through a different number.)

376 exchange (300 Area) users:

Dial paging access number 85.

Wait until a continuous tone is received, then dial in the 3-digit pager code number.

If the terminal is ready to page the receiver, a beeping signal will be heard for a few seconds.

If the terminal is busy, a ring back signal (the sound heard when the telephone called is ringing) will be heard. The ring back signal will continue until the terminal is ready for your paging call, then the beeping "acknowledgment" will be heard.

When the beeping signal stops, then state the voice message to be sent to the paging receiver dialed.

When the voice message is completed, hang up the telephone.

373 exchange (100 Area) users:

Dial 85 and 3-digit pager number, wait for a few seconds for beeping signal, then proceed with voice message.

Telephone Systems

There is a telephone system available for use by UNC to alert employees to emergency conditions. This system is activated by Patrol upon request from management personnel when proper identification, list number, and message number to be transmitted is provided. Proper identification consists of requestor's name, job title, and call-back number. Patrol will verify person making the request by implementing a call-back. It is also the contractor's responsibility to assure the listings for the ADAS VI are up-to-date and correct. Test schedules and user requirements for ADAS VI telephone systems follows.

Automated Dialing Alert System VI (ADAS VI). The ADAS VI system will normally be tested on the first Monday of each month as scheduled below. When the first Monday is a holiday, the alarm system will be tested the next day (Tuesday).

Response to a ADAS VI Message. When the ADAS VI is activated a programmed message is sent to those listed notifying them of the emergency. After receipt of the message press '0' on the touch tone pad for 2 seconds to acknowledge the call.

SECTION H
HAZARDOUS WASTE MANAGEMENT TRAINING

The information contained in this section outlines the Personnel Training Program for the 1706-KE Waste Treatment System operated by UNC Nuclear Industries (UNC) for the U.S. Department of Energy in accordance with the requirements of the WAC-173-303-330 and 40 CFR 264 and 270. Modules 1, 2 and 9 are received by all employees involved with the operation of the 1706-KE Waste Treatment System. Any new information or corrections to this section will be furnished when available. Modules 3 thru 14 constitute training available for personnel involved with the UNC Hazardous Waste Management Program (HWMP), including the 1706-KE Waste Treatment System.

H-1 OUTLINE OF TRAINING PROGRAM

The UNC Environmental Protection group is responsible for the development and administration of the comprehensive training program for persons involved in the HWMP. A Hazardous Waste Engineer from the Environmental Protection group shall be the instructor conducting all training. A training manual will be developed by the Environmental Protection group by June, 1987 which will detail the following training program elements:

A. UNC policies and standards concerning hiring criteria, job specifications, position descriptions, and performance standards.

B. Organization of the HWMP.

C. General health, safety, and environmental policy pertaining to HWMP personnel.

D. A description of the training modules, course contents, test methods, and training methods which will be utilized.

E. A general description of the treatment, storage, and disposal (TSD) facilities and handling and transportation procedures.

F. Emergency response procedures and implementation of the contingency plan.

G. Training administration and record keeping procedures.

See Appendix H-1, "Training Outline."

H-1(a) Introductory Training by Job Title and Duties

A Hazardous Waste Engineer from the Environmental Protection group will provide training for new employees. Successful completion of introductory training will be accomplished during the first six months of employment. New employees will not work unsupervised until introductory training is complete. Introductory classroom and on-the-job training will be provided for each applicable position. The training course/job descriptions matrix depicted in Figure H-1 outlines how training will be accomplished for each job title.

See Appendix H-2, "Job Titles and Descriptions"

A Hazardous Waste Engineer will provide additional/recurring training on a yearly recertification basis. This will consist of an annual recertification exam on the employee's anniversary date for each job description listed in Appendix H-2. New modules not directly related to a job description may also be presented in order to provide additional background and/or cross training. These courses will be offered on a quarterly basis or as the need arises.

H-1(b) Training Content, Frequency, and Techniques

Training and required courses of study will be divided into modules which are specific to appropriate training topics. Fourteen modules will be provided, and offered on a quarterly or as-needed basis. All HWMP working at the 1706-KE Waste Treatment System are required to take the Modules One, Two and Nine (specific to the facility involved), at a minimum. A description of each module is as follows:

A. Module One

Title: Introduction to the Hazardous Waste Management Program

Time: 2 hours

Method: Lecture/Question and Answer

Conducted by: A Hazardous Waste Engineer or designated alternate

Course Content:

1. Description of HWMP organization

2. Review job descriptions of individuals within the program

3. Performance standards

4. General health, safety, and environmental policies which govern all aspects of the program

5. General description of the authority and regulations of government agencies which interface with the HWMP, including WDOE, USDOE, USEPA, and OSHA

6. Training program requirements

7. General description of the UNC HWMP facilities and associated operations

Reading Assignment: Read the training manual and review the Part A and B permit applications.

B. Module Two

Title: Facility Specific Training: The 1706-KE Waste Treatment System

Time: 1 hour

Method: Tour/Lecture/Question and Answer

Conducted by: A Hazardous Waste Engineer or designated alternate

Course Content:

1. Locate the work station of the Building Emergency Director

2. Understand the waste treatment system employed at 1706-KE TSD Facility

3. Understand the limits and controls on the types of waste which can be placed into the 1706 KE Waste Treatment System.

4. Tour the 1706-KE Waste Treatment System Facility

5. Tour the waste analysis laboratory at the 184-KE Building

Reading Assignment: Study 1706-KE Waste Treatment System schematic and topographic maps of the 100-KE Area.

C. Module Three

Title: General Aspects of Handling, Storage, Treatment, and Transportation of Hazardous Wastes

Time: 1 hour

Method: Lecture/On-the-Job Training (OJT)

Conducted by: Hazardous Waste Engineer/Involved Managers

Course Content:

1. Recognition of corrosive chemical hazards.

2. Comprehension of chemical hazards associated with waste materials including toxicology and health effects.

3. Basic concepts of the chemistry of hazardous materials.

4. Classification of materials into categories which present similar health, safety, or environmental threats.

5. Physical and chemical properties of materials in broad hazard classifications.

6. General methods and procedures for handling, storing, treating, disposing, and transportation of wastes which mitigate the hazardous nature of various materials.

7. Location and use of reference materials which contain information relating to toxicology, chemical characteristics, recommended first aid procedures in the event of exposure, and recommended storage and handling procedures.

Reading Assignment: Review NIOSH/OSHA publication - "Occupational Health Guidelines for Chemical Hazards".

Evaluation: Observe trainees in class setting.

D. Module Four

Title: Concepts of the Chemistry of Hazardous Materials

Time: 1 hour

Method: Lecture

Conducted by: A Hazardous Waste Engineer or designated alternate

Course Content:

1. Definitions of factors which cause materials to be hazardous:

    a. Toxic materials

    b. Reactive materials

    c. Materials which react to produce toxic hazards

    d. Explosives

    e. Environmental toxins and contaminants

    f. Corrosives/caustics

    g. Carcinogens, teratogens, mutagens

    h. Radioactive materials

2. Thermodynamic aspects of chemical reactions

3. Factors which influence reaction rates

4. Chemical equilibrium

5. Definitions of factors relating to fire and explosion hazards:

    a. Flash point

b. Fire point

c. Auto ignition point

d. Upper and lower explosive limits

e. Vapor density

f. Ignition sources

g. Flammability classification systems

6. Concepts of detonation and deflagration

7. Boiling liquid expanding vapor explosion (BLEVE)

8. Classes of chemicals with potential explosive hazards:

a. Nitrogen compounds

b. Organic peroxides

9. Classes of toxic materials:

a. Heavy metals

b. Organic solvents

c. Pesticides

d. Toxic gases

10. Definition of factors relating to corrosivity:

    a. pH, acidity, alkalinity

    b. Acid/base strength

    c. Neutralization

    d. Buffer systems

11. Definition of factors relating to reactivity of wastes:

    a. Water reactive

    b. Air reactive

    c. Oxidation and reduction

12. Definition and explanation of factors relating to carcinogenicity, mutagenicity, and teratogenicity.

13. Definition and explanation of factors relating to radioactive hazards.

14. Definition and explanation of factors relating to hazards associated with infectious materials.

E. Module Five

Title: Procedures for Handling, Storing, Treatment, Packaging, and Transportation of Hazardous Waste.

Time: 1 hour

Method: Lecture/Demonstration/OJT

Conducted by: A Hazardous Waste Engineer or designated alternate

Course Content:

1. Procedures for pickup and transportation of wastes from on-site generation points to the Hanford Hazardous Waste Storage Building (616 Bldg.).

2. Procedure for acquiring samples of wastes intended for analysis.

3. Description of record keeping and administrative procedures relating to waste pickup, analysis, transportation, and disposal.

4. Review of health, safety, and environmental policies relating to handling, storing, treatment, packaging, and transportation of wastes including brief risk assessment.

5. General description of policies relating to the use of personal protective compatibility

6. Concepts and procedures relating to chemical compatibility and container compatibility.

7. Spill/release prevention, cleanup, and reporting.

8. Standards of primary container integrity and labeling.

9. Standards of secondary container integrity and labeling.

10. Utilization of space and layout of storage areas within the Hanford Hazardous Waste Storage Building (616 Bldg.).

11. Methods of packing primary and secondary containers.

12. Spill prevention procedures, equipment, and cleanup.

13. Identification of possible routes of access by which contaminants could enter the environment.

14. Identification of methods by which materials could enter the body.

15. Methods by which materials may be neutralized prior to packaging and transportation.

16. Procedures for sealing and labeling containers intended for transportation to the disposal site (on and off site).

17. Procedures for loading chemical transportation vehicles for shipment to disposal site (on and off site).

18. Administrative requirements related to transportation of wastes to the disposal site (on and off site).

19. TSD facility inspection requirements.

20. Procedures for dealing with non-sudden releases (e.g., leakers).

21. Drum handling/forklift procedures overview.

Reading Assignment: Review pertinent section of 1706-KE Waste Treatment System Part A Application.

Evaluation: Observe trainees during participation in demonstrations.

F. Module Six

Title: Use of Personal Protective Equipment and Emergency Equipment located at UNC HWMP Facilities.

Time: 1 hour

Method: Demonstration/Lecture/Tour/OJT

Conducted by: Industrial Hygienist, Hanford Fire Department Personnel, and a Hazardous Waste Engineer or designated alternate.

Course Content:

1. Policies and procedures concerning use of personal protective equipment including:

   a. Eye protection

   b. Face protection

   c. Hand protection/gloves

   d. Lab coats

   e. Protective footwear

   f. Encapsulation suits

2. Policies and procedures concerning use of self-contained breathing apparatus, filter masks, organic vapor masks, and dust cartridge respirators.

3. Location and contents of first aid kits.

4. Policies and procedures concerning use of bomb blanket (discussion of other resources available for handling suspected dangerous explosives).

5. Capabilities of "Acid King," "Chemturion," "Fyrepel," and Tyvex" encapsulation suits. Policies and procedures governing utilization of encapsulation suits.

6. Location and use of portable fire extinguishers at UNC HWMP facilities.

7. Location and use of fire alarms at UNC HWMP facilities.

8. Utilization of over pack drums for spill/leak containment.

9. Utilization of absorbent pillows and/or other appropriate absorbent materials.

10. Overview of fire department equipment, capabilities, and general emergency response procedures.

Evaluation: Observation of trainees during participation in demonstrations.

G. Module Seven

Title: Emergency Procedures/Implementation of the UNC Hazardous Materials Contingency Plan

Time: 1 hour

Method: Lecture/Question and Answer

Conducted by: Emergency Coordinator

Course Content:

1. Definition of emergency and/or conditions which will prompt implementation of the contingency plan.

2. Roles of UNC HWMP personnel, Hanford Fire Department, Hanford Police Department, and UNC administrators in an emergency.

3. Notification procedures.

4. Staging areas.

5. Utilization of monitoring equipment.

6. Spill containment procedures.

7. Routes of access/egress from facilities.

8. Activation/use of fires suppression equipment.

9. Procedures for suspending operations during emergency conditions.

10. Facility decontamination procedures.

11. Evaluation methods and procedures.

12. Procedures for handling emergencies involving hazardous materials which threaten to enter or have entered the air, surface water, or groundwater.

13. Run-off and run-on control.

14. Aspects of the interface with federal, state, county, and city agencies which may have long-term or immediate involvement in emergencies.

15. Use of eye washes and deluge showers.

Reading Assignment: Read the UNC Hazardous Materials Contingency Plan (UNIMA-2 Volume 1-5) and the DOT publication, "Emergency Action Guide for Selected Hazardous Materials."

H. Module Eight

Title: Protecting the Environment from Contamination by Hazardous Waste/Decontamination Procedures

Time: 1 hour

Method: Lecture/Discussion

Conducted by: Certified Industrial Hygienist and a Hazardous Waste Engineer

Course Content:

1. Mechanisms by which contaminants enter the human body and other biological systems.

2. Factors related to pesticide exposure.

3. Description of Hanford Site water and sewage systems.

4. Description of threats to the community posed by airborne contaminants.

5. Delayed health effects of frequent low-level exposure to hazardous materials.

6. Medical surveillance.

7. Description of the topography in the vicinity of UNC HWMP facilities which relates to the potential for water contamination.

8. Ground and surface water systems on the Hanford Site.

9. Flood plain information.

10. Water sampling and analysis procedures.

11. Facility decontamination procedures.

12. Environmental decontamination procedures.

13. Dangers associated with PCBs.

14. Suspension of operations in the event of a contamination incident.

15. Personal decontamination including:

    a. Decontamination of clothing and body surfaces.

    b. Use of deluge showers and eyewashes.

Reading Assignment: Study topographic maps, flood plain maps, and water system schematics of the Hanford Site.

I. Module Nine

Title: Waste Sampling Procedures for the 1706-KE Waste Treatment System

Time: 1 hour

Method: Discussion

Conducted by: Senior Chemist and a Hazardous Waste Engineer or designated alternate

Course Content:

1. Review procedures for acquiring samples from the 1706-KE Waste Treatment system.

2. Review procedures for record keeping, notification, and documentation of analysis result.

3. Review operation and capabilities of analytical apparatus.

4. Review calibration maintenance and repair procedures for analytical apparatus.

5. Review specific test methods to be utilized for varieties of chemical species present in the system.

6. Review policies and procedures related to safe handling and disposition of samples in the 184-KE analytical laboratory.

Reading Assignment: Review the EPA waste analysis plan, SW-846, and other authoritative references relating to analytical procedures.

Evaluation: Confirm understanding by oral responses during discussion.

J. Module Ten

Title: Record Keeping and Administrative Procedures

Time: 1/2 hour

Method: Discussion/OJT

Conducted by: A Hazardous Waste Engineer or designated alternate

Course Content:

1. Maintenance of personnel files and position descriptions.

2. Maintenance of training records and log.

3. Maintenance of permits, permit applications, and comprehensive plans.

4. Maintenance of forms and records related to chemical disposal requests and wastes analysis lab test results to include off-site incinerated materials and volumes, stored wastes and transported wastes.

5. Maintenance of inspection logs.

Reading Assignment: Read permit applications

Evaluation: Oral

K. Module Eleven

Title: First Aid Training

Time: 8 hours

Method: Lecture/Demonstration

Conducted by: WISHA certified instructor

Course Content:

1. Standard industrial first aid instruction, including CPR.

L. Module Twelve

Title: Review of Procedures and Use of SCBA Equipment and Encapsulation Suits

Time: 2 hours

Method: Discussion/Demonstration

Conducted by: Hanford Fire Department Specialist and Rockwell Respiratory Protection Department Specialist

Course Content:

1. Review of procedures and use of SCBA equipment, Chemturion, and Fyrepel encapsulation suits.

2. Practice using equipment.

Evaluation: Oral/Observation

M. Module Thirteen

Title: Radio Procedures

Time: 1 hour

Method: Discussion/Demonstration

Conducted by: Hanford Dispatcher

Course Content:

1. Review radio operations and capabilities.

2. Review policies concerning use of the radio.

3. Review use of call signs and standard voice communication procedures.

Evaluation: Oral/Observation

N. Module Fourteen

Title: Simulated Hazardous Materials Emergency Incident

Time: 2 hours

Method: Programmed problem solving and decision making exercise. Group participation and simulation.

Conducted by: Emergency Coordinator

Course Content:

1. The Office of Emergency Planning will develop a written, programmed simulation of events leading to an emergency involving hazardous materials. Participants will respond to changing events by describing their activities and decisions at each point as the situation develops.

Evaluation: Group evaluation

H-1(c) Training Director

The Hazardous Waste Training Director will be an engineer from the Environmental Protection group. This training director will be qualified to conduct the training based on his/her academic background and/or experience.

H-1(d) Relevance of Training to Job Position

Titles, job descriptions, and requisite qualifications of personnel involved in the HWMP are set forth in Appendix H-2. (Comprehensive detailed job descriptions for each position are maintained by the Personnel Office. The identity of individual who occupy these positions is also recorded there). Figure H-1 depicts the detail of each job description's training from the modular format.

The Hazardous Waste Engineer will conduct an annual training review each December which will consist of the following elements:

1. Review training records to ensure that training has been provided in accordance with the plan set forth in this document.

2. Placement of a signed "memo for the record" in the training file of each program participant indicating that the annual review has been accomplished.

3. Review content of training modules in order that modules reflect current practices and lessons learned.

4. Conduct a group meeting of all HWMP participants and get feedback and ideas concerning relevance and adequacy of training.

H-1(e) Training for Emergency Response

Training is adequate to ensure that personnel are able to respond effectively to emergencies and are familiar with emergency procedures, emergency equipment and emergency systems. This is assured by training encompassing specific topics. These topics are covered in Section H-1(b) modular training as follows:

1. Using, inspecting, repairing, and replacing facility emergency and monitoring equipment. Included in modules 5, 6, 7, 11, 12, 13, and 14.

2. Parameters for automatic waste feed cutoff.

3. Communications and alarm systems. Included in modules 2, 5, 6, 7, 13, and 14 where applicable in operation of a facility.

4. Response to fire and explosions. Included in modules 3, 4, 5, 6, 7, 8, 11, 12, 13, and 14.

5. Response to groundwater contamination. Technical expertise is available from Battelle - Pacific Northwest Laboratories. Technology and response techniques have been developed and implemented.

6. Shutdown of operations. Included in modules 7, 8, and 14, where applicable, in operation of a facility.

H-2 IMPLEMENTATION OF TRAINING PROGRAM

The training program has been implemented and a schedule has been prepared starting October 1, 1986 (which commences the new fiscal year for UNC) which outlines the personnel training for the year.

All employees will receive introductory training within six months of their date of hire or their transfer to a new position. Personnel will not work in unsupervised positions until they successfully complete the training course. Upon successful completion of the necessary training, the employees name,

payroll number, and job title will be entered on the Attendance/Training Input Form (Figure H-2) and added to the employee permanent training record maintained by the Training Department.

Records of each individual's formal training are maintained in the Personnel Office. Training records of current employees will be kept until closure of the facility. Records of former employees are kept for at least three years from the date the employee last worked at the facility.

The training outline is on file in the Environmental Protection office and is available for review. Provisions are made for updating and reviewing courses, as necessary, to ensure RCRA compliance.

Job Title	MODULE NUMBER/TITLE 1/ Intro to Program	2/ Tour of Facil-ities	3/ General	4/ Concepts	5/ Procedures	6/ Personal Protec-tion	7/ Emergency Procedures	8/ Environ-mental Protection From Spills	9/ Waste Sampling	10/ Records	11/ First Aid	12/ SCBA Encap-sulation	13/ Radio Proc.	14/ Haz. Mat. Incident
Engineer	B	C	B	C	C	C	A	A	C	A	C	C	C	C
Operator (Chemical, Nuclear, Heavy Equipment)	A	A	A	C	A	A	A	C	C	A	C	A	C	B
Chemical Tech.	A	C	A	A	C	A	A	C	A	C	C	C	C	B
Light- & Heavy Duty Drivers & Riggers	A	A	A	C	A	A	A	C	C	A	C	A	C	B
Decontamination & Decommissioning Workers	A	C	B	C	C	A	A	C	C	C	C	C	C	A

A = Extensive Instruction

B = Limited Instruction

C = Broad Coverage Instruction

FIGURE H-1. LEVEL OF TRAINING FOR HAZARDOUS WASTE PERSONNEL

UNC NUCLEAR INDUSTRIES	ATTENDANCE/TRAINING INPUT FORM

(PLEASE PRINT ONLY)

TO: RECORDKEEPING

THE FOLLOWING PEOPLE HAVE ATTENDED AND COMPLETED THE COURSE OR TRAINING LISTED BELOW.

Course Title	Class Date(s)	Class Length/Hours

Instructor	Shift ☐ A ☐ B ☐ C ☐ D ☐ E

LAST NAME	INIT.	PAYROLL NO.	AREA	CONTR.	JOB TITLE	UNC REGULAR TEMP.

TO BE COMPLETED BY INSTRUCTOR – GENERAL COURSE/TRAINING DATA

TEST GIVEN	(If Yes)	TYPE OF TEST	TESTS ATTACHED	TOTAL NUMBER TRAINED
Yes ☐ No ☐	Oral ☐	Written ☐ Other _____		

A & S

- ☐ #552 5th Shift
- ☐ Fuel Processing /Operations
- ☐ Operating Engrs.
- ☐ R&CT
- ☐ Radiation Zone Worker
- ☐ Criticality Safety
- ☐ First Aid/CPR
- ☐ Industrial Safety
- ☐ Hazardous Material
- ☐ Respiratory Protection

Rx.O.T.

- ☐ MOD I
- ☐ Level II
- ☐ Level III
- ☐ Certification
- ☐ Re-Certification

Skills

- ☐ Maint. Trng.

TA&D

- ☐ Instructor Fundamentals
- ☐ Advanced Inst. Trng.
- ☐ FUELS TRAINING 300 AREA
- ☐ Other _____

General Comments: _____

DISTRIBUTION: White - Recordkeeping Yellow - Originator

APPENDIX H-1

HAZARDOUS WASTE MANAGEMENT TRAINING

I. General Introduction

A. Introduction to Hazardous Waste Management Program

B. Facility Specific Training: 1324-N Surface Impoundment

C. General Handling, Storage, Treatment, Transportation

II. Specific Safety Issues

A. Chemistry of Hazardous Materials

B. Handling, Storage, Treatment, Packaging, and Transportation Procedures

C. Emergency/Protective Equipment

D. Hazardous Materials Contingency Plan

E. Environmental Protection Procedures

III. Administrative Procedures

A. Waste Sampling

B. Record/Administration

IV. Emergency Training

A. First Aid

B. Encapsulation/SCBA Equipment

C. Radio Transmission

D. Simulated Hazardous Materials Emergency

Job Title:

Operator (Chemical, Nuclear, and Heavy Equipment)

Level of Responsibility:

Actual hands-on handling, packaging, labeling, disposition of hazardous waste

Qualifications:

Experience and qualification testing

Job Elements:

- Implementation of Hazardous Waste Management Program elements by procedure
- Packaging/labeling of hazardous waste for shipment
- Handling of hazardous waste prior to disposition
- Loading of hazardous waste for shipment

Job Title:

Chemical Technician

Level of Responsibility:

Handling of samples and analytical equipment

Qualifications:

Academic degree or qualification testing

Job Elements:

- o Receive and log samples
- o Quality Control
  - Training
  - Record keeping
  - Equipment maintenance
- o Analyze samples as per Environmental Protection Agency and State of Washington protocol

Job Title:

Light- and Heavy-Duty Drivers and Riggers

Level of Responsibility:

Transportation of hazardous waste

Qualifications:

Experience and qualification testing

Job Elements:

- Inspect and verify shipments as to proper packaging, labeling, and manifestations
- Loading and hazardous waste for shipment
- Transportation of hazardous waste as per Department of Transportation regulations

Job Title:

Decontamination and Decommissioning Worker

Level of Responsibility:

Hazardous material spill cleanup

Qualifications:

Experience and qualification by testing

Job Elements:

- Provide response to a spill of hazardous materials for purposes of cleanup
- Stabilize area after cleanup operations

SECTION I
CLOSURE REQUIREMENTS

The 1706-KE Waste Treatment System utilizes tanks, containers, an ion exchange column, an evaporation unit, and a condenser to treat radioactive mixed wastes generated in the laboratories in the 1706-KE Building. A schematic of this system is shown in Figure I-1. The laboratories in the 1706-KE Building are used to conduct chemical and physical tests of various systems at N-Reactor. This system will be closed under final status according to the following closure plan.

This closure plan was prepared in accordance with the requirements of 40 CFR 264.110 through 116, 119 and 120, 264.178, 264.197, 270.14(b)(13), and WAC 173-303-610(3), 630(10), 640(5), and 860(4)(a)(xiii).

The purpose of this section is to demonstrate that the U.S. Department of Energy Richland Operations Office (DOE-RL) has considered all activities necessary to completely close the 1706-KE Waste Treatment System. It is understood that this closure plan will become a part of the final facility permit for the 1706-KE Waste Treatment System.

Closure activities will be implemented during the designated time period. The closure period will begin at the time of the final acceptance of waste and will end when closure, in accordance with the approved closure plan, is certified by an independent registered professional engineer. DOE-RL will notify the Washington Department of Ecology (WDOE) or the U. S. Environmental Protection Agency (EPA) at least one-hundred-eighty days prior to the expected closure date.

DOE-RL will amend this closure plan whenever changes in the operating plans or facility design may affect the closure of the 1706-KE Waste Treatment System. This plan will also be amended whenever there is a change in the expected year of closure.

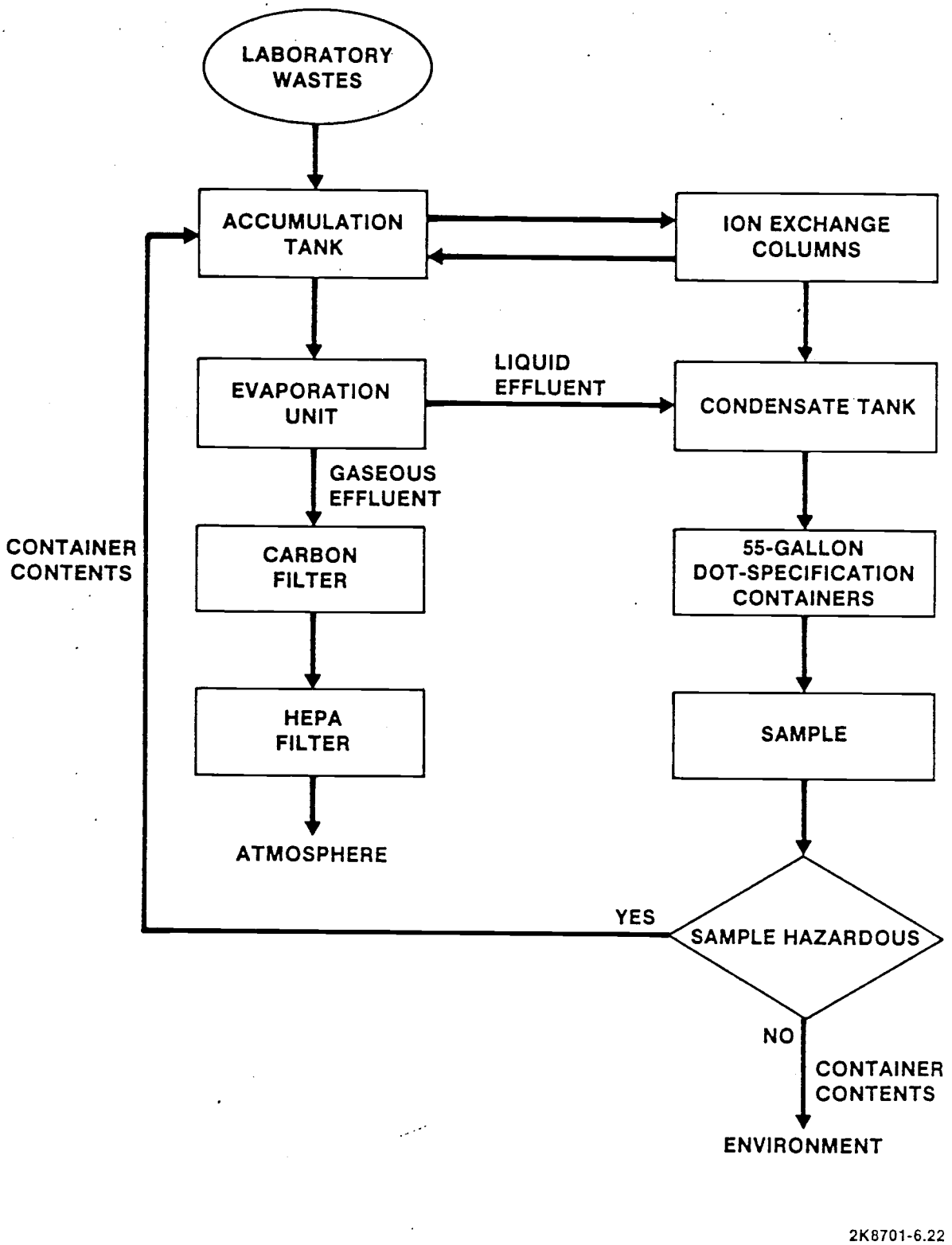

FIGURE I-1
PROCESS FLOW FOR THE 1706-KE WASTE TREATMENT SYSTEM

If DOE-RL requests a permit modification to authorize a change in the operating plans or facility design of the 1706-KE Waste Treatment System, a request for modification of the closure plan will be made at the same time. If a permit modification is not needed to authorize the change in operating plans or facility design, the request for modification of the closure plan will be made within sixty days after the change in plans or design occurs.

At the time of the implementation of closure activities, it is possible that either the Washington Department of Ecology (WDOE) and/or the Environmental Protection Agency (EPA) may be the regulating authority. Submittals required in this Section will be sent to the appropriate authority at the time of closure. The addresses of these regulating authorities are as follows:

Regional Administrator
Region X
U.S. Environmental Protection Agency
1200 Sixth Avenue
Seattle, Washington 98101

Director
Washington Department of Ecology
Mail Stop PV-aa
Olympia, Washington 98504

The location of official copies of the Closure Plan is given in Appendix I-1. The responsible person for storage and updating these copies is given in Appendix I-2. The certification of closure is found in Appendix I-3.

I-1 CLOSURE PLAN

I-1a Closure Performance Standard

The DOE-RL will initiate and monitor the closure activities for the 1706-KE Waste Treatment System. Personnel involved in the closure activities will be under the supervision of a person knowledgeable in the safe handling of both radioactive and dangerous wastes. Appropriate protective clothing and

equipment, if required, will be specified to ensure personnel protection. Upon completion of the closure activities, all regulated material will have been removed from the facilities.

The 1706-KE Waste Treatment System will be closed in a manner that protects human health and the environment and minimizes or eliminates escape of hazardous waste, hazardous waste constituents, leachate, contaminated rainfall, or waste decomposition products to the ground or surface waters or to the atmosphere.

This closure plan provides for closure of the 1706-KE Waste Treatment System in a manner that will:

- Minimize future maintenance needs through complete removal of all radioactive mixed wastes. All facility equipment will be tested to insure it is free of contamination;

- Protect human health and the environment through use of proper health and safety procedures;

- Minimize the escape of hazardous waste, hazardous waste constituents, leachate, contaminated rainfall, or waste decomposition products to the ground or surface waters or atmosphere, through the use of proper handling and disposal techniques for all contaminated materials; and

- Return the land to the appearance and use of surrounding land areas to the degree possible given the nature of the previous dangerous waste activity.

I-1b Partial and Final Closure Activities

DOE-RL does not expect to perform a partial closure of the 1706-KE Waste Treatment System. Therefore, all closure activity will be for final closure of the system. Closure will proceed according to the steps identified in Figure I-2.

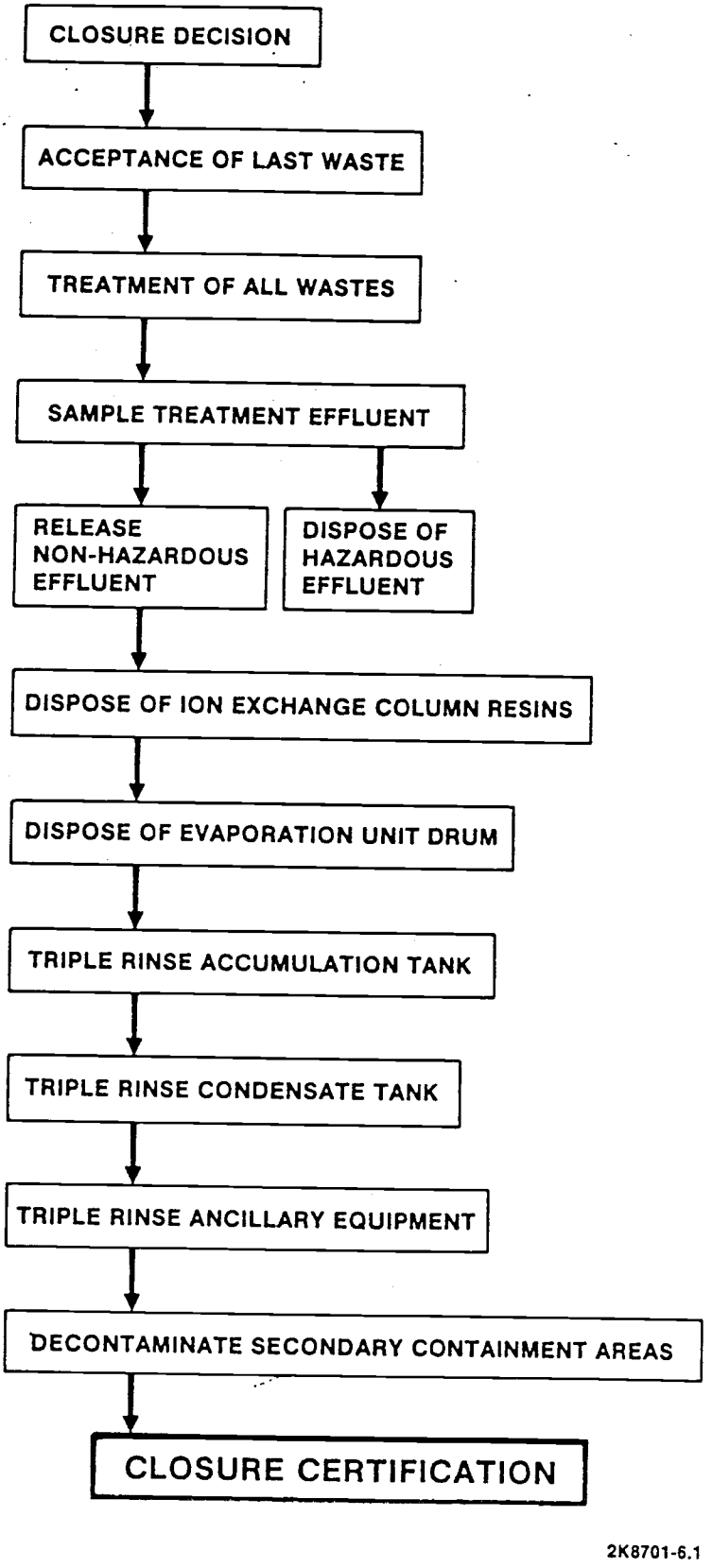

FIGURE I-2
1706-KE WASTE TREATMENT SYSTEM CLOSURE KEY STEPS

The expected year of closure is 1995 ± 2 years. At least 180 days prior to the date of receiving the last regulated waste batch, DOE-RL will notify the appropriate regulating agency of the intent to close the 1706-KE Waste Treatment System. Within 30 days after receiving the last regulated waste, DOE-RL will direct the appropriate Hanford Site Contractor to implement this approved closure plan. Within 60 days after receiving the last regulated waste, all mixed radioactive liquid wastes which have not been treated in the system will be transferred to the DOE Waste Management Contractor in the 200 Areas of the Hanford Site. Within 90 days after receiving the last regulated waste, the piping, tanks, and other system components will be flushed with water to remove residual materials. The rinsate will be transferred to the DOE Waste Management Contractor for treatment in the 200 Areas of the Hanford Site. Within 180 days of receiving the last regulated waste, DOE-RL will submit the required certification of closure to the regulating authority.

No soil or groundwater sampling will be conducted at the 1706-KE Facility. This waste treatment unit is located completely within the 1706-KE Building, and there is no pathway for potential contamination of the soil or groundwater underlying the building. All radioactive mixed wastes will be removed from the 1706-KE Waste Treatment System at the time of final closure.

I-1c Estimate of Maximum Waste Inventory

The maximum possible inventory of waste in storage at the 1706-KE Waste Treatment System is 1,500 gallons of radioactive mixed wastes. This includes the wastes which may be stored in the accumulation tank, the evaporation unit, the condensate collection tank, the container storage area, and in any of the associated piping.

The waste accumulation tank is a 550-gallon tank, and the condensate collection tank is a 96-gallon tank. The ion exchange column is capable of containing up to 40 gallons at any one time, and up to 30 gallons may be stored in the evaporation unit. The container storage area is capable of

holding up to 550 gallons of waste. Approximately 15% of the total volume of wastes in the system at any one time may be stored in the system piping and pumps.

I-1d Inventory Removal, Disposal or Decontamination of Equipment

Closure of the 1706-KE Waste Treatment System will ensure that dangerous wastes and dangerous waste residues are removed, and that equipment and other materials containing or contaminated with dangerous waste are decontaminated. Removal and decontamination activities will ensure that dangerous waste residues do not exceed the following levels:

a) for dangerous wastes listed under WAC 173-303-081 or 173-303-082 or designated by the characteristics WAC 173-303-090, wastes will be removed to background environmental levels; and

b) for dangerous wastes designated by WAC 173-303-084 or 173-303-101 through 173-303-103, a technical assessment will be conducted in accordance with the Washington Department of Ecology's Final Cleanup Policy - Technical (July 10, 1984. This technical assessment will provide the basis for developing concentration limits for those dangerous wastes,

unless alternative concentration levels are developed and agreed upon by the EPA or WDDE.

I-d(1) Closure of Containers

All containers remaining in the container storage area of the 1706-KE Waste Treatment System will be decontaminated or removed at the time of closure of the facility. Containers holding effluent (condensate) from the 1706-KE Waste Treatment System will be sampled if they have not already been sampled. If the analyses of these samples indicate that the contents of the containers are not radioactive mixed wastes, then the contents of the containers will be discharged in an environmentally acceptable manner as non-regulated wastes.

If the contents of any of the containers are determined to be hazardous and/or radioactive wastes, the containers will be sealed and shipped to the Hanford Site Waste Management Contractor for storage and/or additional treatment.

Once the contents of all containers containing nonhazardous wastes have been removed, these containers will be triple-rinsed, and the rinsate collected. Samples of the rinsate will be taken and sent to a laboratory for analyses. All samples of waste, rinsate, and swipe samples will be taken according to the methods described in SW-846, "Test Methods for the Evaluation of Solid Wastes," Section One, "Sampling of Solid Wastes." The analyses will include all parameters necessary to determine whether the rinsate is a designated waste. This list of parameters can be found in Table I-1.

Swipe samples will also be taken of the interior of the containers. If the analyses of the swipe samples and the rinsate samples indicate no hazardous waste constituents are present, then the containers will be shipped to another facility on the Hanford Site for re-use.

If the analyses of the samples indicate that the containers still contain hazardous waste residues, the containers will be sealed and shipped to the Hanford Site Waste Management Contractor for disposal.

The secondary containment device for the container storage area will be inspected at the time of closure of the 1706-KE Waste Treatment System. Swipe samples will be taken of the surface of the plastic risers and the aluminum pan. The samples will be analyzed for the parameters listed in Table I-1. If analyses of these samples indicate that the plastic risers and/or aluminum pan contain hazardous waste residues, these structures will be decontaminated.

The secondary containment structures will be decontaminated by triple-rinsing the structures. Following the rinse, swipe samples will again be taken of the surface of the plastic stands and the aluminum pan. The samples will be analyzed for the parameters listed in Table I-1. If analyses of these samples indicate that the surface of the secondary containment structures no longer contain hazardous waste residues, the samples will be released as nonhazardous wastes and the plastic stands and the aluminum pan will be removed and sent to another facility for re-use.

TABLE I-1

CLOSURE WASTE ANALYSES

CHARACTERISTIC	PARAMETER	TEST
Toxicity	Metals	ICP
	Zinc	SW-846, #6010
	Calcium	
	Barium	
	Cadmium	
	Chromium	
	Silver	
	Sodium	
	Nickel	
	Copper	
	Vanadium	
	Aluminum	
	Manganese	
	Potassium	
	Iron	
	Magnesium	
	Beryllium	
	Usinium	
	Strontium	
	Antimony	
	Ions	Ion Chromatography
	Nitrate	
	Sulfate	
	Fluoride	
	Chloride	
	Phosphate	
Total Organic Carbon		SM #505
Corrosivity	pH	SW-816, #9040
Reactivity		
Ignitability		

If the analyses indicate that the plastic stands and/or the aluminum pan still contain hazardous waste residues, these structures will be placed in sealed containers and shipped to the Hanford Site Waste Management Contractor for disposal.

I-1d(2) Closure of Tanks

No special equipment will be required for the closure of the tanks and associated piping of the 1706-KE Waste Treatment System. All wastes and waste residues will be removed from the 1706-KE Waste Treatment System in an environmentally acceptable manner at closure. Flushing of the system piping and tanks will be done to remove those materials regulated under WAC 173-303. This will be confirmed by the taking of swipe samples of the tank interior. All swipe samples and samples of rinsate will be taken according to the methods of section one of SW-846. These samples will be analyzed to determine whether any waste residues are designated. The parameters to be analyzed for are identified in Table I-1. All materials removed from the tanks will be transferred to the Hanford Site Waste Management Contractor for disposal.

If analyses of the swipe samples indicate that contamination has not been removed from the tanks by the flushing, the equipment will be disassembled and transferred to the Hanford Site Waste Management Contractor for disposal in a manner in accordance with all applicable regulations. In addition, areas surrounding the facilities will be inspected for indications of leaks or spills. Any areas showing signs of contamination (such as discoloration, corrosion, etc.) will also be sampled and analyzed. Any materials found to be contaminated will also be transferred to the Hanford Site Waste Management Contractor for disposal in accordance with all applicable regulations.

Removal of radioactively contaminated equipment is governed by DOE Order 5820.1, "Radioactive Waste Management," Chapter V, "Decontamination and Decommissioning of Surplus Facilities." The requirements of this order will be met when the tanks and associated piping of the 1706-KE Waste Treatment System are removed. Any equipment contaminated during closure will be steam

cleaned. If the cleaning water is contaminated, it will be contained, packaged and disposed of in a manner consistent with approved hazardous waste management procedures in effect at the time of closure.

I-1d(3) Closure of Physical, Chemical, and Biological Treatment Units

I-1d(3)(a) Ion Exchange Columns

The ion exchange column of the 1706-KE Waste Treatment System will be removed from service at the time of closure of the facility. The resins in the ion exchange column will be removed, collected, and shipped to the Hanford Site Waste Management Contractor for disposal as a solid radioactive mixed waste.

The ion exchange column will then be triple-rinsed with clean water. The rinsate will be collected, sampled, and analyzed. The sample will be analyzed for the parameters listed in Table I-1. If the analyses indicate that the rinsate is nonhazardous and nonradioactive, it will be released as a non-regulated waste.

Swipe samples will then be taken of the interior of the ion exchange column. These samples will also be analyzed for hazardous and radioactive constituents identified in Table I-1. If the column is found to be free of hazardous and radioactive constituents, it will be removed and sent to another area of the Hanford Site for re-use. If the ion exchange column is contaminated, it will be sealed and shipped to the Hanford Site Waste Management Contractor for proper disposal.

I-1d(3)(b) Evaporation Unit and Condenser

The waste drum in the evaporation unit will be removed and sealed at the time of closure. This drum will be shipped to the Hanford Site Waste Management Contractor for disposal as a radioactive mixed waste.

The piping in the evaporation unit will then be triple-rinsed. The condenser will also be triple-rinsed. The rinsate will be collected, sampled, and analyzed for the parameters listed in Table I-1. If the rinsate is shown to

be nonhazardous and nonradioactive it will be disposed of as a non-regulated waste. If the rinsate is determined to be hazardous and/or radioactive, it will be sent to the Hanford Site Waste Management Contractor for proper treatment.

Swipe samples will then be taken of the interior of the evaporation unit and the condenser. These samples will also be analyzed for the hazardous constituents identified in Table I-1. If the evaporator and condenser are found to be free of hazardous and radioactive constituents, they will be removed from the 1706-KE Building and sent to another area of the Hanford Site for re-use. If the evaporator and condenser are contaminated, they will be sealed and shipped to the Hanford Site Waste Management Contractor for proper disposal.

I-1d(4) Closure of the Secondary Containment Structure

The secondary containment structure for the tanks, ion exchange column, and evaporation unit will also be decontaminated at closure if there are any reports of a spill(s) to the curb during the operation facility. The curb will then be triple-rinsed with clean water. The rinsate will be collected, and samples of the rinsate analyzed for the hazardous waste constituents identified in Table I-1.

Swipe samples will also be taken of the surface of the curbed area. If the results of analysis of the swipe samples and the rinsate samples reveal no hazardous waste residues, the rinsate will be released as a nonhazardous waste.

If the analyses indicate that the rinsate does contain hazardous waste, residues, the containerized rinsate will be sent to the Hanford Site Waste Management Contractor for treatment. If the swipe samples indicate that the surface of the secondary containment curb is still contaminated with hazardous waste residues, the curb will then be steam cleaned.

All waste products from the steam cleaning process will be collected. These wastes will be sampled, and the samples will be analyzed for hazardous waste constituents identified in Table I-1. If the wastes are shown to be nonhazardous and nonradioactive, they will be released as non-regulated wastes. If they are found to be contaminated with hazardous and/or radioactive waste residues, the steam cleaning waste containers will be sealed and shipped to the Hanford Site Waste Management Contractor for treatment.

Swipe samples will again be taken of the surface of the secondary containment curb to determine if the hazardous waste residues have been removed. If the steam cleaning has not removed the hazardous waste residues from the curb, further treatment options will be considered at that time.

I-1g Schedule for Closure

The DOE-RL plans to initiate closure of the 1706-KE Waste Treatment System in calendar year 1995 ± 2 years.

Closure of any of the 1706-KE Waste Treatment System shall be completed within 180 days of the final receipt of regulated waste. The following events will be completed on or before the time indicated below:

Time/Day	Activity
-180	Notification of intent to close
0	Final regulated waste accepted
+30	Closure initiated
+60	All waste treated or transferred
+90	All system components flushed with water, all residual regulated waste removed and transferred to DOE Waste Contractor, and system components sampled and analyzed for radioactive and/or hazardous contamination
+180	Certification of closure completed

I-1h Extensions for Closure Time

Extensions for closure time, if needed, will be requested in accordance with 40 CFR 264.113(a) and (b), and WAC 173-303-610.[610(4)]

I-2 POST-CLOSURE PLAN

This section is not applicable. All wastes from the 1706-KE Waste Treatment System will be removed at closure. Therefore, no post-closure activities will be conducted at the 1706-KE Waste Treatment System.

I-3 NOTICE IN DEED

A notice in deed is not required for containers, tank systems or chemical, physical, and biological treatment units.

I-4 CLOSURE COST ESTIMATE

The Federal government is exempt from this requirement [40 CFR 264.140(c) and WAC 173-303-620(1)(c)].

I-5 FINANCIAL ASSURANCE MECHANISM FOR CLOSURE

The Federal government is exempt from this requirement [40 CFR 264.140(c) and WAC 173-303-620(1)(c)].

I-6 POST-CLOSURE COST ESTIMATE

This section is not applicable as there will be no post-closure activities conducted at the 1706-KE Waste Treatment System.

I-7 FINANCIAL ASSURANCE MECHANISM FOR POST-CLOSURE CARE

This section is not applicable as there will be no post-closure activities conducted at the 1706-KE Waste Treatment System.

I-8 LIABILITY REQUIREMENTS

The Federal government is exempt from this requirement [40 CFR 264.140(c) and WAC 173-303-620(1)(c)].

WP #9142A

SECTION J
OTHER FEDERAL LAWS

In conformance with the requirements of 40 CFR, 207.3, Considerations Under Federal Law, the following Federal Laws have been reviewed. For the U.S. Department of Energy's Hanford facility, none of these laws requires consideration or adoption of any practical permit conditions or requires the denial of a permit.

1. The Wild and Scenic Rivers Act of 1968 (PL 90-542 and Subsequent Amendments). An act to provide for a National Wild and Scenic Rivers System, and for other purposes.

2. The National Historic Preservation Act of 1966 (PL 89-665 and Subsequent Amendments). An act to establish a program for the preservation of additional historic properties throughout the Nation, and for other purposes.

3. The Endangered Species Act of 1973 ((PL 93-205 and Subsequent Amendments). An act to provide for the conservation of endangered and threatened species of fish, wildlife, and plants, and for other purposes.

4. The Coastal Zone Management Act of 1972 (PS 92-583 and Subsequent Amendments). An act to establish national policy and to develop a national program for the management, beneficial use, protection, and development of the land and water resources of the Nation's coastal zones, and for other purposes.

5. The Fish and Wildlife Coordination Act of 1934 (PL 121 and Amendments). An act to promote the conservation of wildlife, fish, and game, and for other purposes.

   (PL 85-624) An act to amend the Act of March 10, 1934, to provide for more effective integration of a fish and wildlife conservation program with Federal water-resource development, and for other purposes.

   (PS 89-72) An act to provide uniform policies with respect to recreation and fish and wildlife benefits and costs of Federal multiple-purpose water resource projects, and for other purposes.

The Hanford Site is also operated pursuant to the rules and/or regulations promulgated under the Clean Water Act, the Clean Air Act and its subsequent amendments, as well as the requirements of other applicable Federal laws through ongoing facility planning and operational monitoring/compliance activities of the Safety and Quality Assurance Divisions.

WP #9125A

SECTION K
CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

_____ _____
Date Signed

U. S. Department of Energy
Richland Operations
Owner and Operator

WP #9124A