020803

SNO-STR-97-015

FILE: 080-62T

Construction Report.
Guy Jonkmans & Davis Earle
Feb 25, 1997

Introduction:

The facility has been constructed as described in the application for construction license. All of the major components have been obtained and either have already been installed or are ready to be put in place. This report with the accompanying appendices will make clear the as built facility and will include sections on the shielded pit to house the neutron generator, the neutron generator, the gas target assembly, the gas handling equipment and the monitoring system.

The Shielded Pit:

The shielding and pit to house the neutron generator is shown in the attached Inco Drawing 17-702-E-7154. Fig 1 shows the top of the shielding and its location in the underground laboratory. This figure also shows the crane to be used to remove the top two shielding blocks so that the neutron generator can be installed. Inco Drawing 17-702-E-A2280 shows the modifications to the mezzanine floor that were required so that the crane could extent over the shielding blocks. Figs 2 and 3 are close up photos of the exposed components of the shielding and of the back of the blocks showing the opening for the neutron generator power cables. The test report on the concrete cylinders is also appended. The density of three different samples was 2472, 2459 and 2461 kg/m3.

The wall of the pit was waterproofed by coating with polyurethane. The pit floor joint and the top joint between the pit and a steel cover flange (see Fig. 2) was sealed with polyurethane grout. A report on the sealing of the pit has been prepared by Doug Hallman and is attached. The purpose of this sealing and the drainage below the pit into an adjacent sump is to prevent water from entering the pit.

The Neutron Generator:

The neutron generator, Model A320, was purchased from MF Physics Corp. and has been described in our construction application. It has been installed in Bldg 513 at CRL, AECL where it has been operated occasionally for warranty purposes and also to check out the gas target components and the radioactive gas handling equipment. Fig 4 is a photo of the neutron generator as it presently exists in Bldg 513. The photo shows the 7' long tube containing the neutron generator supported between three plates which are held apart by three rods. Near the middle of the tube is a 1' of shielding and a fast neutron detector, clamped to the generator tube. The neutron source is actually 7" from the bottom of the tube. By looking closely at the photo one can see a narrow knurled ring around the tube about 1" above the floor/wall intersection which is the actually position of the (d,t) target in the tube.

The Gas Target Assembly:

The gas target assembly is shown in CRL Drawing dated Nov '95. Fig. 5 is a photo of the assembly showing the two separate gas target chambers and the translator which moves the chambers up and down so that one or the other surrounds the neutron generator. The entire assembly sits on the bottom plate shown in Fig. 4 with the teflon

plug at the end of the neutron generator tube sitting in the hole in the bottom of the Al bracket shown in Fig. 5.

The Gas Handling Equipment

i) The gas control board

The gas control board was designed to control the flow of gas for various SNO calibration devices. The radioactive sources produced are ^{8}Li, ^{16}N and ^{17}N sources. Helium is used as a carrier gas for ^{8}Li deposited into a salt aerosol. CO_2 is injected into the He stream and is used as a quenching and a carrier gas. For the ^{16}N source, ^{16}O is used for both the target and carrier gas. For the ^{17}N source, ^{17}O is used for both the target and carrier gas. The gas control board is shown in Fig. 6.

All the piping and gas control components shown on Fig. 6 are mounted on a 1/4" aluminum board. The board itself is mounted on a custom-made Dexion rack. The 2- and 3-way valves (VA1 through VF1) enable the operator to change the gas used and the flow path of the gas. Several passive gas filters (Swagelock) are positioned at the gas input lines and to remove dust and salt which may be present in the gas. Two pressure relief valves (Swagelock B-400-4) and two solenoid "Shut-Off" valves (ASCOELECTRIC 8262G86-N) are positioned in the input lines as a security measure. The gas flow is controlled by three pre-calibrated, gas flow controllers (MKS 1179A-34CS1VBS). The status of the system is closely monitored at all time by four pressure gauges (P1-P4, PX303-100AS OMEGA) and one vacuum pressure gauge (EDWARDS APG-M-NWIG ST/ST). A recirculation pump (Metal Belows) is used for running the gas system in recirculation mode when the ^{17}N gas is used. Finally, there is a vacuum pump (not shown) connected to VE3 and resting at the bottom of the rack.

After assembly, the gas lines were thoroughly checked for leaks by inserting He gas in the whole system at an over-pressure of five Atm and using a He "sniffer". All connections were tightened until no leaks were detected. Room was left in the system to allow for the insertion of Rn cryo-trap if deemed necessary at a later time.

Table 1 lists the parts used for the gas flow board.

ii) The aerosol oven

The oven is used to heat salt (NaCl) and to produce an aerosol for the efficient transport of ^{8}Li nuclei. Fig. 7 shows a picture of this commercial oven (MDL ILTF035A, MINI MITE TUBE FURNACE). A custom made quartz tube displayed in Fig. 8 is inserted in the furnace with the 50 cm vial resting against the furnace inside walls. Salt fills 25% of the vial. The gas then flows to a second vial (length = 20cm) where it is water cooled. The transition from the vials to the gas line is made by a flexible Glass-end tubing. (See Figs. 9 & 10)

iii) The gas capillary and return lines.

Several hundred feet of gas capillary (Teflon, PFA-T4-062-200) have been bought. Several hundred feet of polyflow gas lines have been bought. They are to be attached to the gas control board, the target chambers and the decay chambers as shown in Fig. 11.

The Monitoring System

i) The hardware box.

The function of the hardware box is to condition the various signals acquired by the sub-systems (DT-generator, pressure gauges, oven, etc) so that their output values can be recorded over the range of the two DAQ cards connected to the computer. As such, it translates the various analog voltages into 0 - 10 volt outputs and routes them to the DAQ cards (Nat. Inst. Lab-PC+ I/O and PC-LPM-16 I/O). It can also control some components through solid state relays. Fig. 12 shows the front panel display of the box. Pressures and target position are indicated via LC display. Fig. 13 shows the wiring of the box. The various inputs, taken from the back plane, are re-routed to a standard flat computer cable connection. The four solid state relay can also be seen on the picture.

The following is a list of the various quantities monitored and controlled.

Monitor:
- 5 Omega Pressure Transducers, 0-100 psiA
- 1 Vacuum Pressure Transducer, 0-760 mTorr
- Oven Temperature, 0-1000 Celsius
- Status of 2 solenoid valves, Open/Closed
- Status vacuum pump, On/Off
- Status 1 recirculation pump, On/Off
- 3 MKS flow controllers, flow readings
- The target position, 1/2
- DT generator, On/Off HV, On/Off
- The fast neutron flux and γ-radiation field, NIM rate meter and analog out

Control:
- Interlock
- 2 Solenoid valves, Open/Close
- 1 vacuum pump, On/Off
- 1 recirculation pump, On/Off
- Oven, On/Off

ii) Computer and software.

The software used to monitor and control components through the DAQ cards was written using a commercial package (LabVIEW). The primary purpose of the computer and software is to display in graphical forms the status of the facility and to log the status to the SNO main computers but it can also shut off the gas flow and DT generator under pre-determined conditions.

The quantities display and recorded are:
- The running mode and status
- The pressure readings, every 10 sec.
- The flow readings, every 10 sec.
- Oven temperature, every 10 sec.
- The target position and time of day.
- The DT generator status, On, Off, duration, HV and pulse rate
- The fast neutron flux and γ-radiation field, every 10 sec.
- Operating gas (^{8}Li, ^{16}N, ^{17}N)

Any deviations from normal running conditions triggers an alarm which is routed to the SNO site monitoring computer.

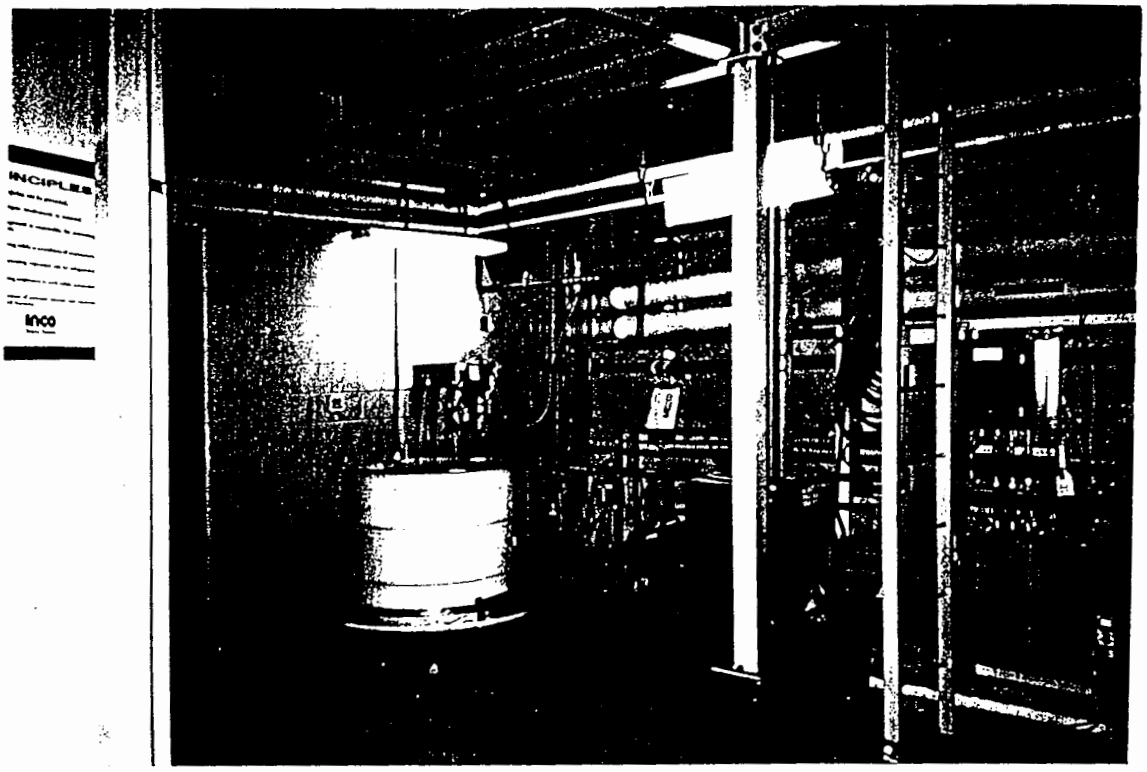
Appendices to Construction Report:

Inco Drawing 17-702-E-7154 Rev 4
Inco Drawing 17-702-E-A2280 Rev 3
CRL Drawing dated Nov. '95 by John Fox
Compressive Strength Test Report from Trow Consulting
Wall Coating Report by Hallman & Oliver

Figs 1 to 13

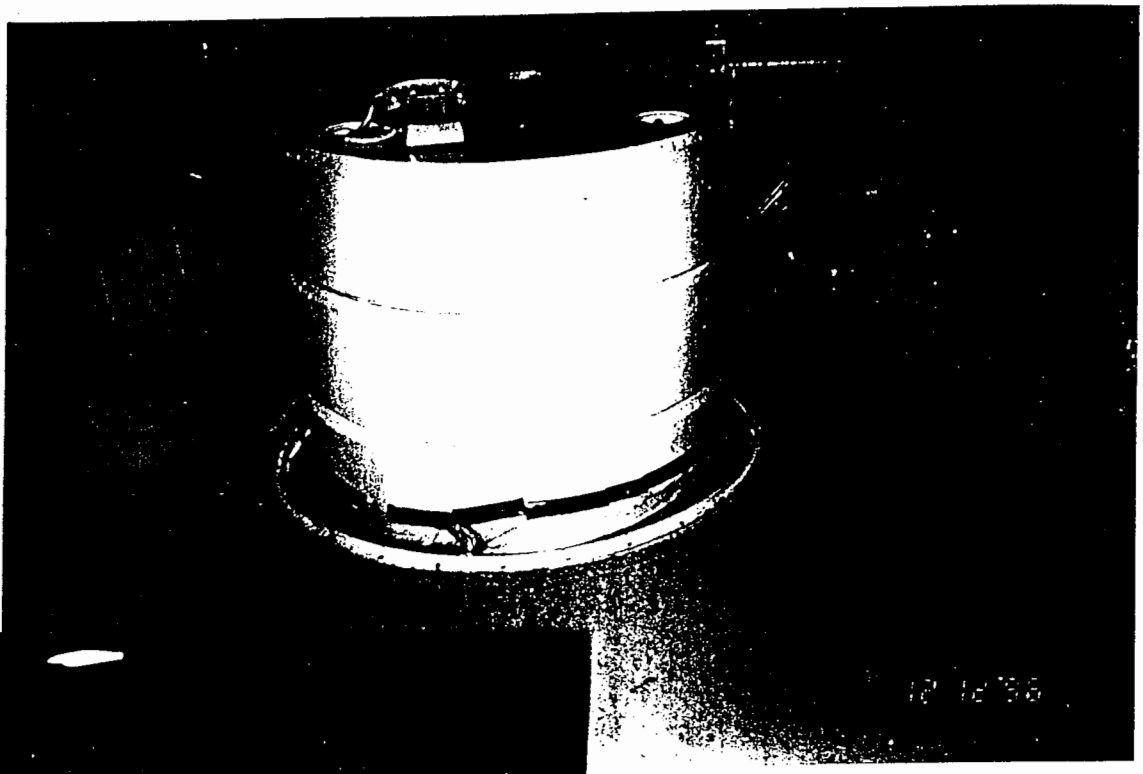
Table 1

View of (d,t) generator shielding location.

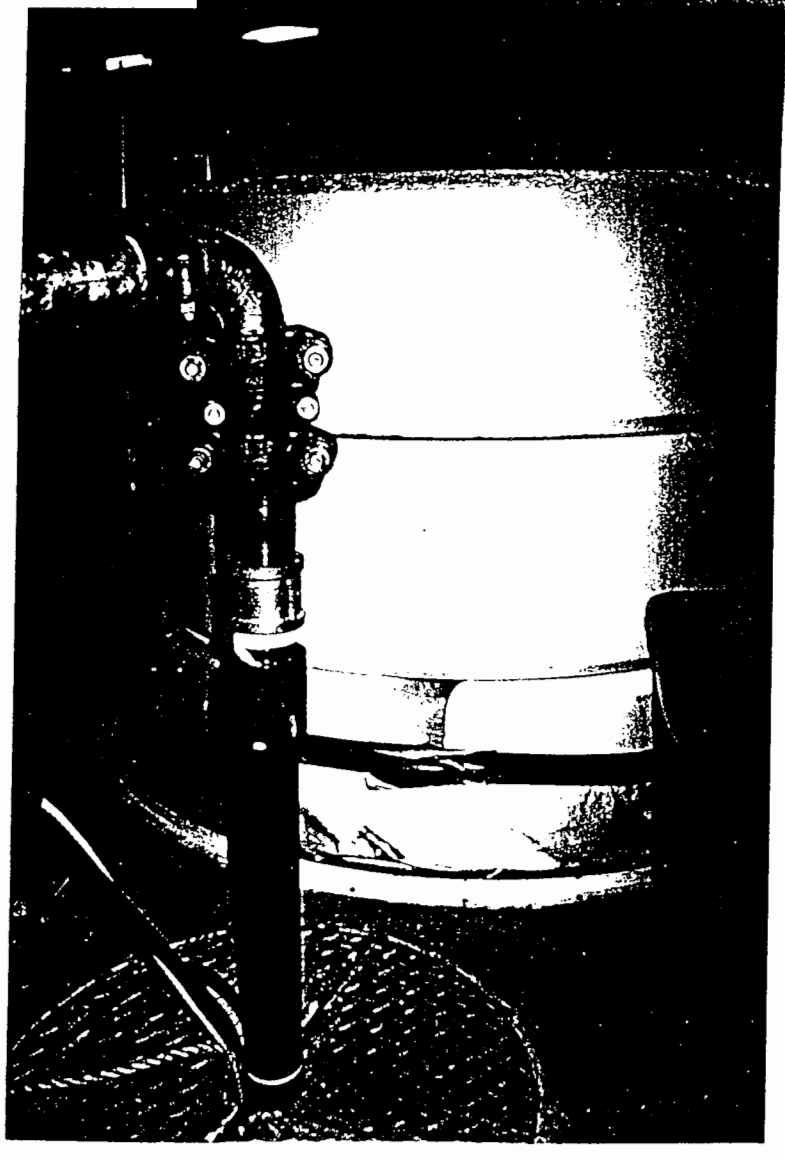


(2)

Closeups of shielding donuts

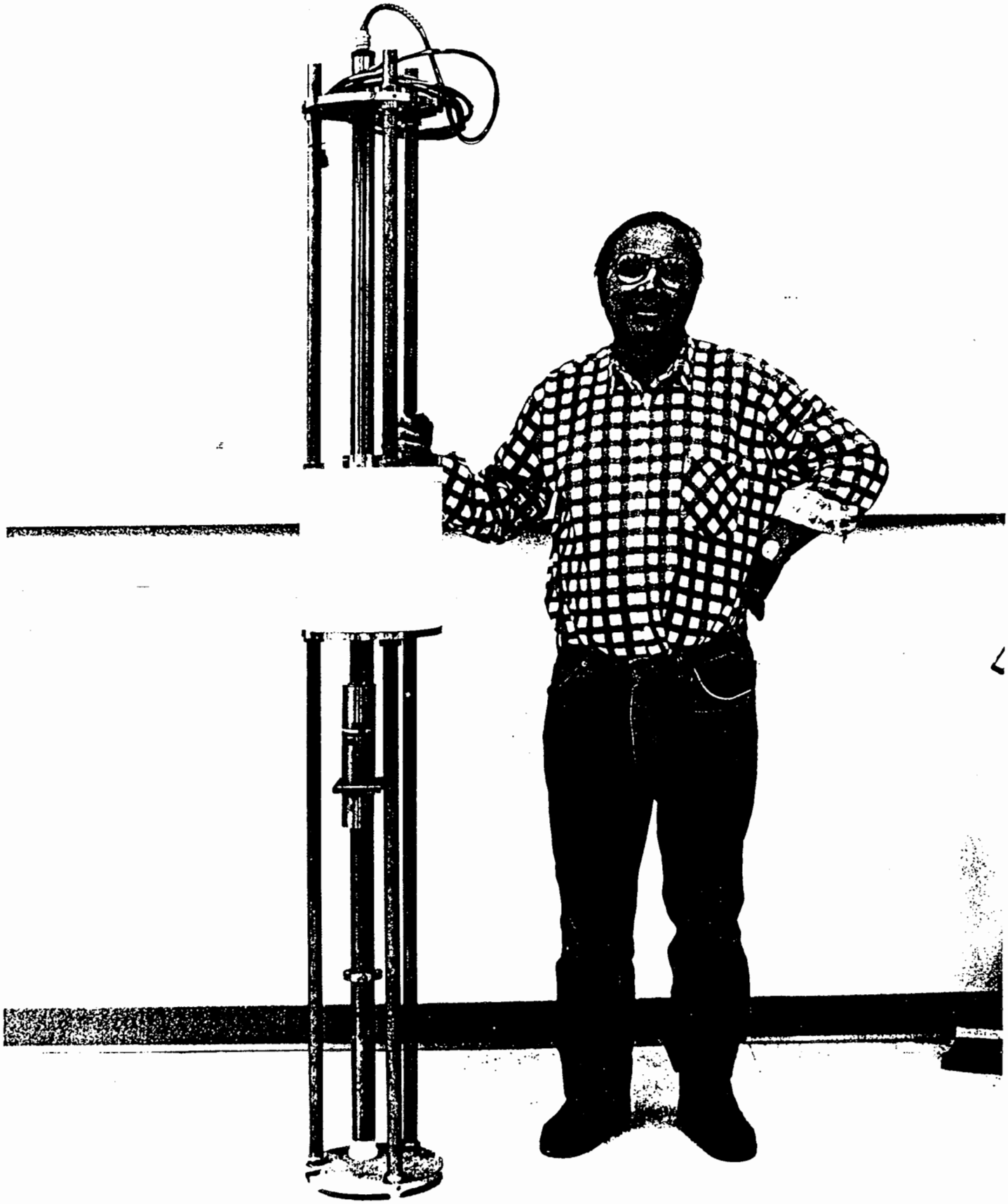


(3)



Back view showing exit for generator cables etc.

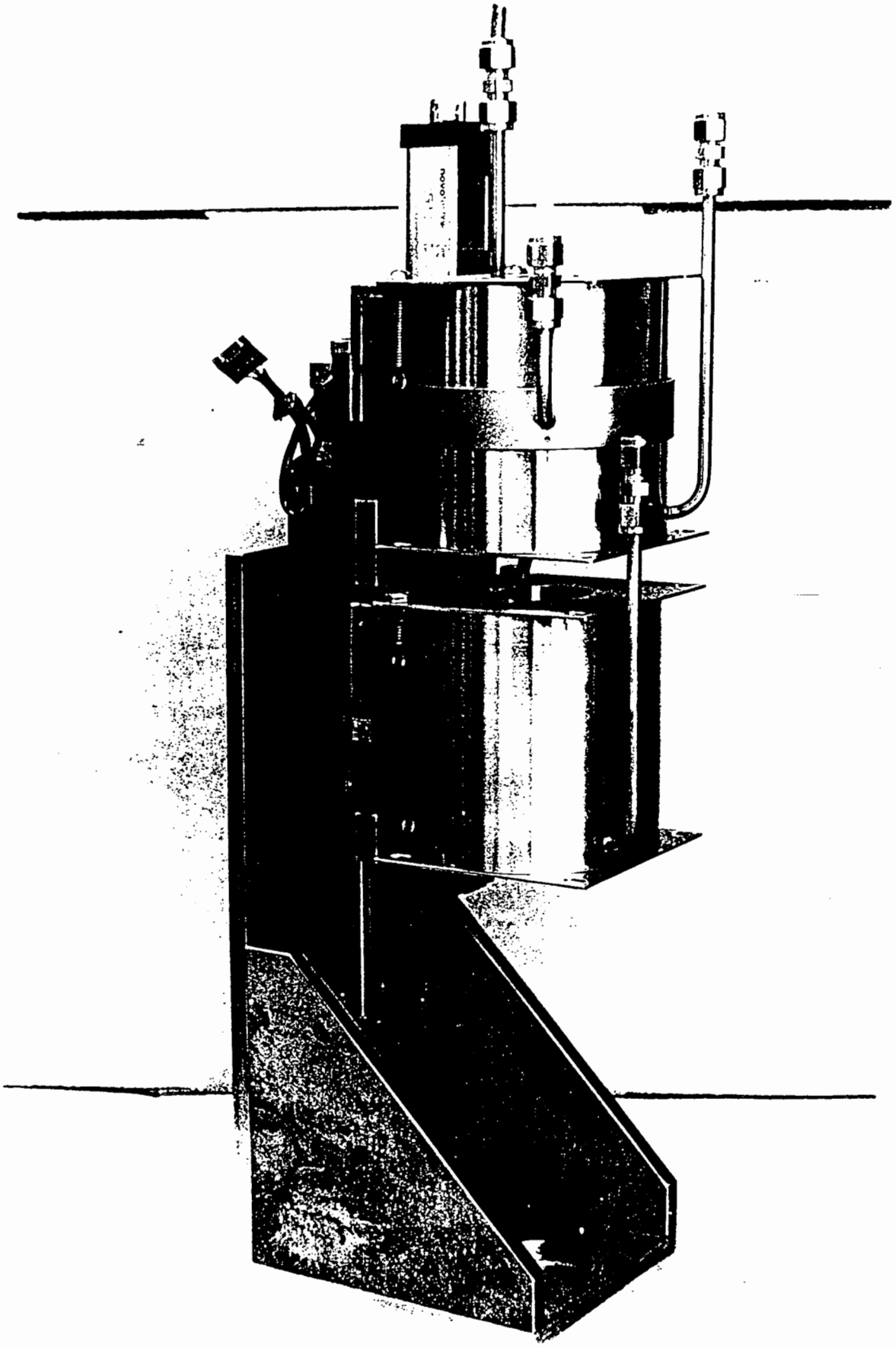
7
(4)



ATOMIC ENERGY OF CANADA LTD
CHALK RIVER ONTARIO

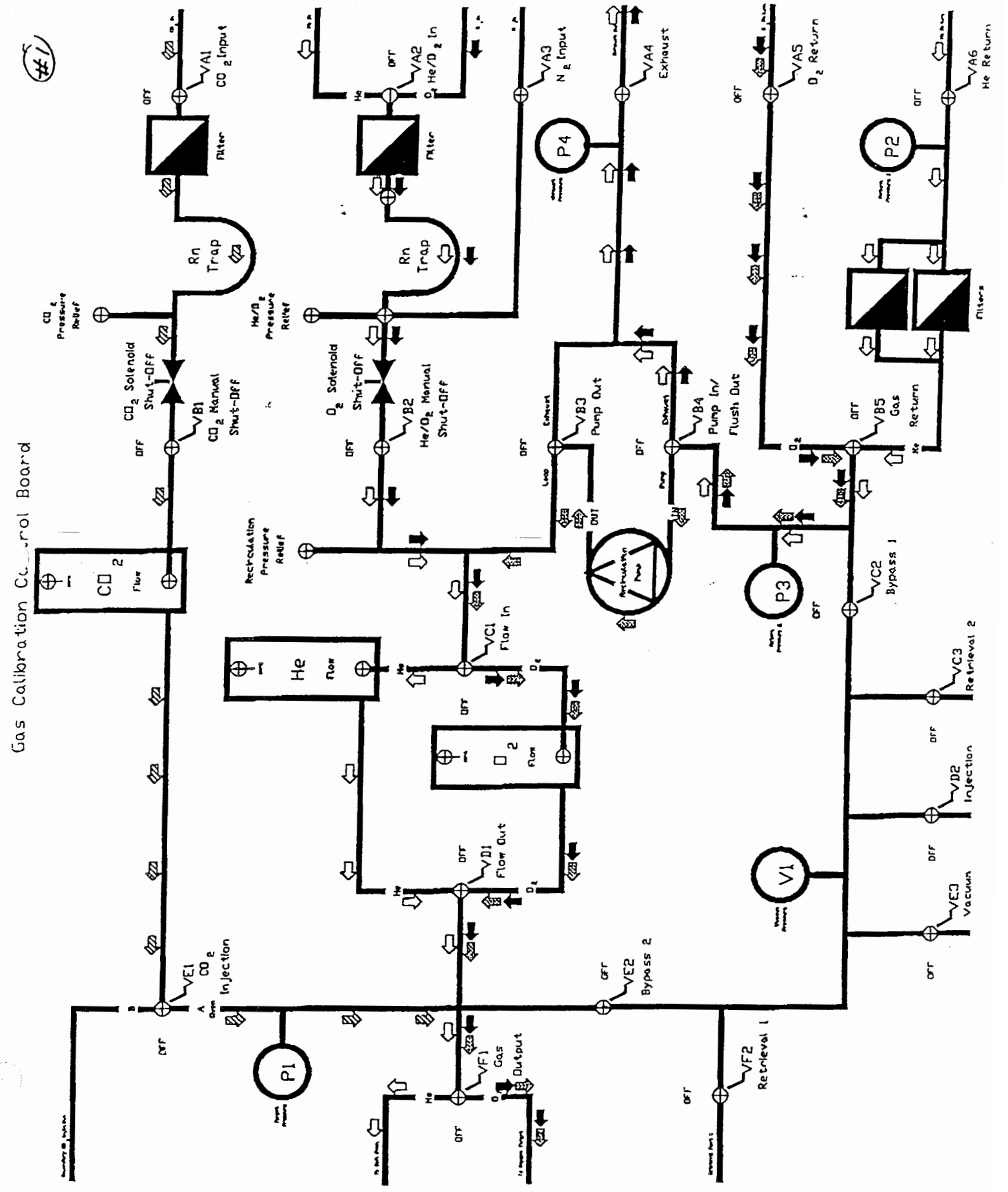
9612-22922-10

(5)



ATOMIC ENERGY OF CANADA LTD
CHALK RIVER ONTARIO

9612-22922-3

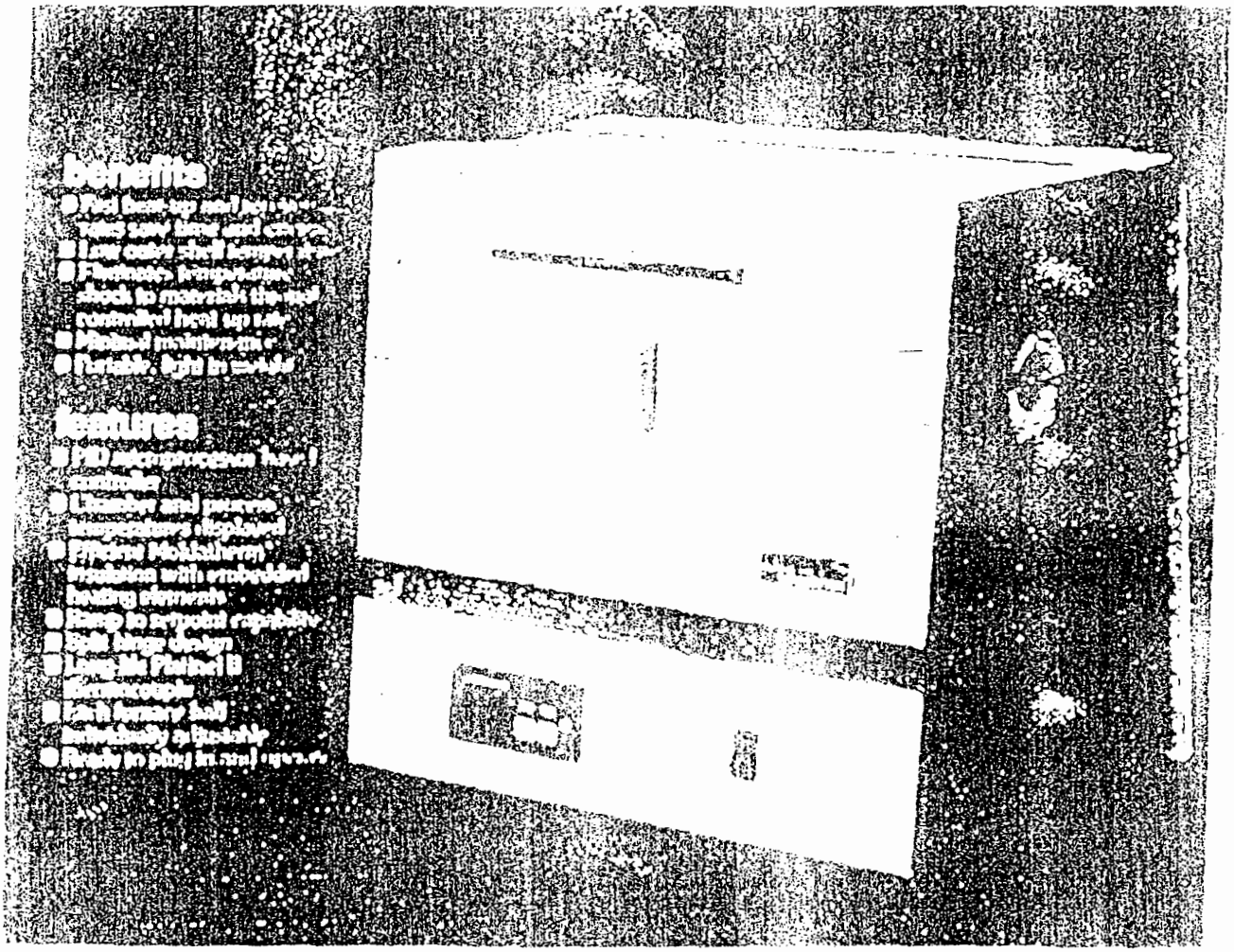

Gas Calibration Control Board
VA1 CO2 Input
VA2 He/O2 In
VA3 N2 Input
VA4 Exhaust
VA5 O2 Return
VA6 He Return
Rn Trap
Rn Trap
CO2 Solenoid Shut-Off
O2 Solenoid Shut-Off
VB1 CO2 Manual Shut-Off
VB2 He/O2 Manual Shut-Off
VB3 Pump Out
VB4 Pump In/ Flush Out
VB5 Gas Return
Recirculation Pressure Relief
CO2 Flow
He Flow
O2 Flow
VC1 Flow In
VC2 Bypass 1
VC3 Retrieval 2
VD1 Flow Out
VD2 Injection
VE0 Vacuum
VE1 CO2 Injection
VE2 Bypass 2
VF1 Gas Output
VF2 Retrieval 1
P1
P2
P3
P4
V1
Filters
OFF

List of parts for Gas-Flow Control Board (Figure 1):

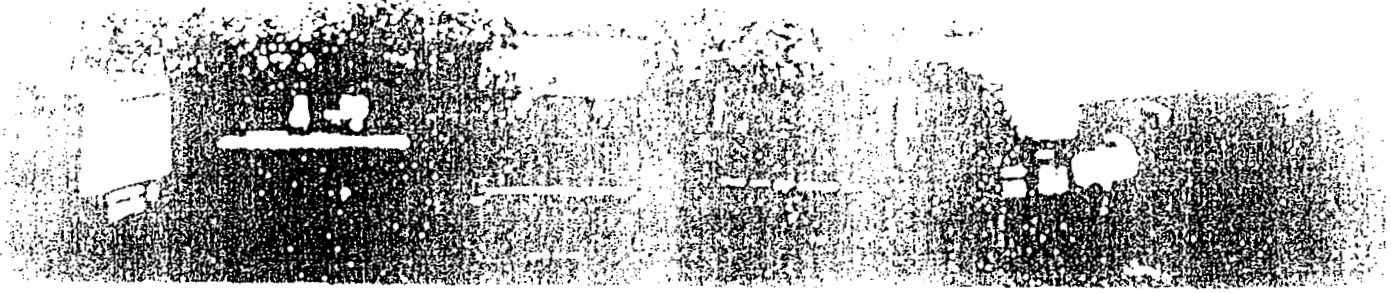
Object	Description	Part Number
VT1 to VT7	7 × Whitey-40 3-way, centre-off Ball Valves, 1/4 Swagelock Fittings	Swagelock Cat. B-43XS4
VB1 to VB8	8 × Whitey-40 On-Off Ball Valves, 1/4 Swagelock Fittings	Swagelock Cat. B-43S4
V1, V2	2 × Whitey Integral Bonnet Needle Valves, 1/4 Swagelock Fittings	Swagelock Cat. B-1RS4
VR1, VR2	2 × Nupro RL3 Low Pressure Proportional Relief Valves with Manual Override Handles, 1/4 Swagelock	Swagelock Cat. SS-RL3S4-MO
F1, F3	3 × Nupro TF removable filters, 0.5 microns, 1/4 Swagelock fittings, 2 in parallel for F3	Swagelock Cat. SS-4TF-0.5μ
VS1	Solenoid valve, normally closed, 110 V excitation, 1/4 NPT Female ends	ASCO Cat. 8262-686-N
P1 to P5	5 × Omega Pressure Transducers; 0-100 psiA, 0.25%, 9-24 V excitation, 0.5-5.5 v output, 1/4 NPT Male ends, with snubbers (ordered separately)	Omega Cat. PX303-100As + PS-4G
PV1	Vacuum Transducer 0-0.02 psiA (0-1000 mTorr) range, 10 mtorr (1% FS) accuracy, rated to withstand 100 psi; preferably gas species independent.	MKS Cat.: Baratron Type 122B-00002 or Omega Type ???
F2	Radon Trap: Either 1/4 OD SS LN2 cooled U-trap for He gas only; OR Dry Ice cooled Activated Charcoal	???
Gas In/Out	11 (+ 1 spare) × Union Bulkheads 1/4 Swagelock	Swagelock Cat. B-400-61
Xducer connectors	6 (+ 1 spare) × Female Branch Tee's 1/4 NPT × 1/4 Swagelock	Swagelock Cat. B-400-3-4TTF
Relief Valve; Vac Xducer connectors	3 (+1 spare) × Union Crosses 1/4 Swagelock	Swagelock Cat. B-400-4
MB pump connectors	2 (+1 spare) × Male connectors 1/4 NPT Male × 1/4 Swagelock	Swagelock Cat. B-400-11-4
Misc. Connectors	2 (+ 1 spare) ×1/4 Swagelock Unions 6 (+1 spare) × 1/4 Swagelok Union Tee's	Swagelock Cat. B-400-6 B-400-3

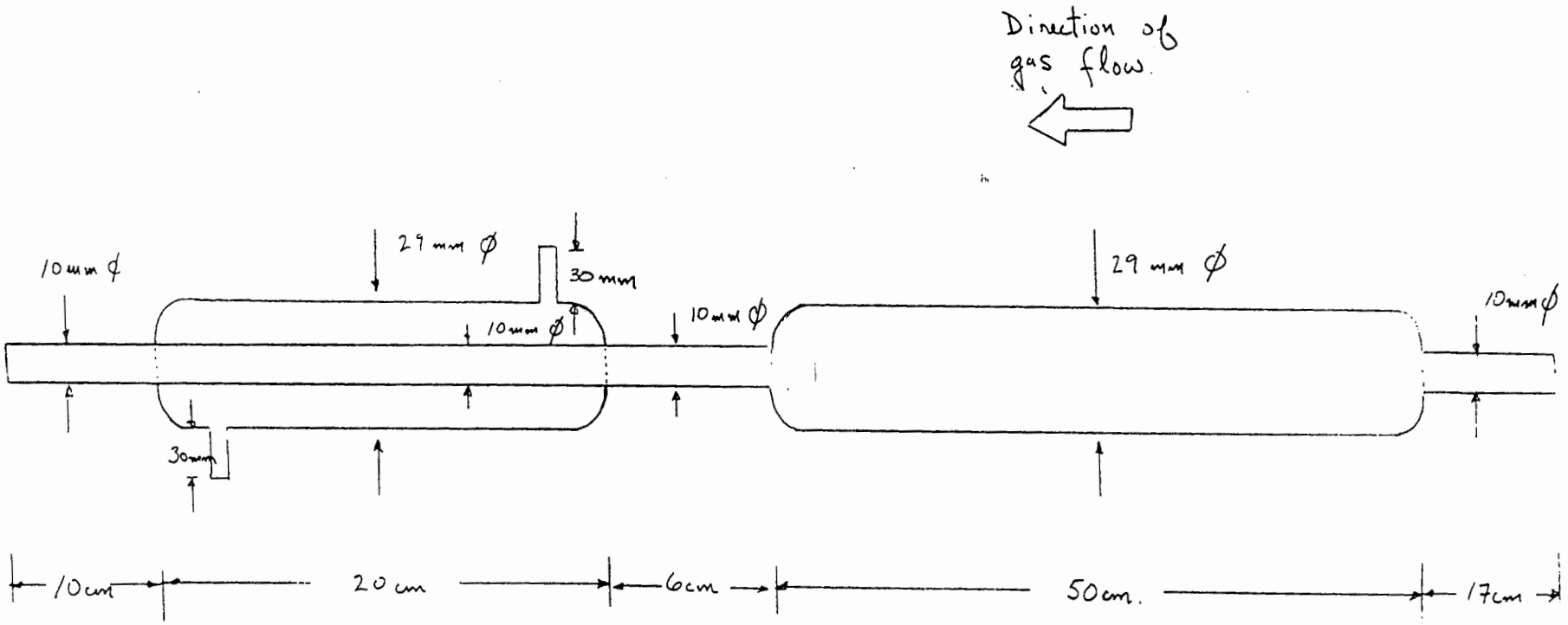
Table #1.

Lindberg Mini-Mite 1100 C tube furnace



Lindberg...the most productive heat source under the sun





Quartz Aerosol Vial

Drawing not to scale.

#8

Flexible Glass-end Tubing

PURPOSE

CAJON Flexible Glass-end Tubing is designed to isolate vibration from glass systems.

APPLICATIONS

Vibration absorbers • Relief for thermal expansion • Low pressure, high purity systems • Industrial and research vacuum systems • Replace expensive vacuum fittings • Permits connection of misaligned components.

FEATURES

CAJON Flexible Glass-end Tubing compensates for expansion, misalignment and vibration in glass systems. The one step glass-to-stainless transition utilizes only the parent materials. No overlapping seams to entrap gases. The nominal produced flexible length is compressible by at least 20% and extendable by 50% (see table of dimensions)

CAJON Flexible Glass-end Tubing is available with glass on both ends or on one end for glass to metal transitions. The glass end is flame cut for smooth edges. Glass ends are stress relieved.

TECHNICAL DATA

MATERIAL

321 stainless steel fused to type 7740 Pyrex glass tube.

TEMPERATURE RATING

Operating temperature ratings are dependent on application and installation methods, cycle life required, O.D. and nominal length of tubing, angular displacement and other variables. Contact your local stocking Distributor for additional information.

PRESSURE RATING

Ultra-high vacuum to 25 PSIG (170 kPa).

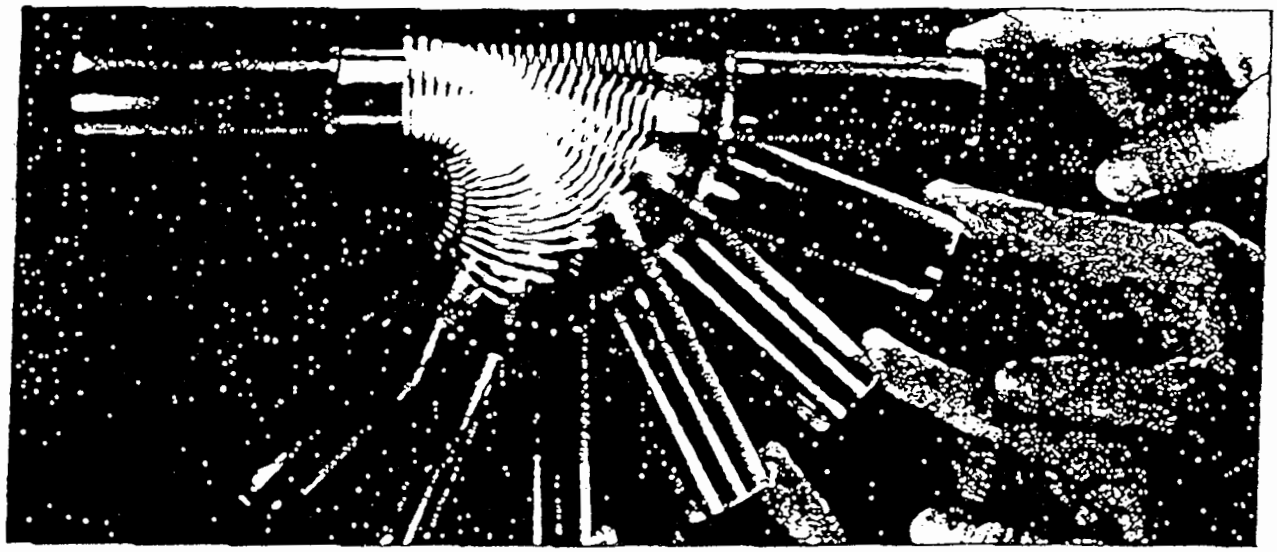
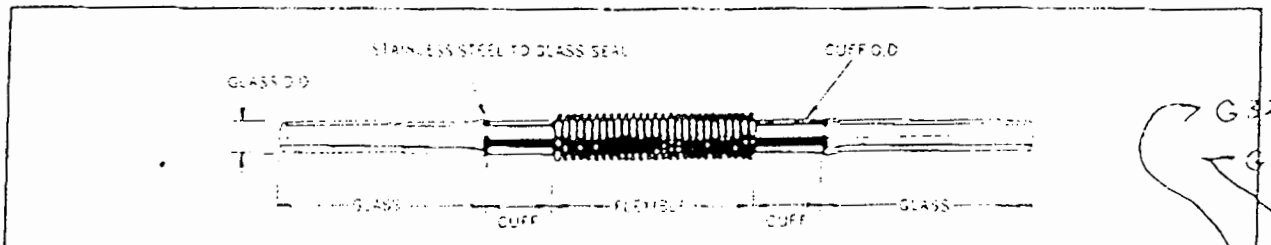


TABLE OF DIMENSIONS



Glass Both Ends

Cuff O.D (inches)	Glass O.D (mm)	Nominal Produced Flexible Length (inches)	Compressed Flexible Length (inches)	Extended Flexible Length (inches)	Glass Length (inches)	Cuff Length (inches)
¼	6	2	1.50	3.00	3.00	.75
⅜	9	3	2.50	4.50	3.00	.75
½	12	3	2.50	4.50	3.00	1.00
¾	19	3	2.50	4.50	3.00	1.00
1	25	3	2.50	4.50	3.00	1.00

Glass One End

Cuff O.D (inches)	Glass O.D (mm)	Nominal Produced Flexible Length (inches)	Compressed Flexible Length (inches)	Extended Flexible Length (inches)	Glass Length (inches)	Cuff Length (inches)
¼	6	2	1.50	3.00	3.00	.75
⅜	9	3	2.50	4.50	3.00	.75
½	12	3	2.50	4.50	3.00	1.00
¾	19	3	2.50	4.50	3.00	1.00
1	25	3	2.50	4.50	3.00	1.00

Glass/Metal Transition Tubes

PURPOSE

CAJON Glass/Metal Transition Tubes are designed for converting from a glass to a metal system through a transition which utilizes only the parent materials.

APPLICATIONS

Transition from a glass system to a metal system • Industrial and research vacuum systems • Corrosive fluid lines • Connect ionization gages to stainless steel vacuum systems • Either end adaptable to CAJON Ultra-Torr Fittings • Stainless steel end adaptable to SWAGELOK Fittings • Connecting valves to glass systems • Sight gages • Manometers • Low pressure, high purity systems • High temperature applications.

FEATURES

One step glass-to-stainless transition eliminates troublesome graded seals • Smooth internal surface for high conductance • Nonporous transition area to prevent absorption and outgassing • Transition structure stronger than parent glass • Transition area offers thermal compatibility with parent materials • Glass end is flame cut for smooth edges • Glass ends are stress relieved.

TECHNICAL DATA

MATERIAL

GLASS TUBE—7740 Pyrex
METAL TUBE—304 stainless steel

TEMPERATURE RATING

Temperatures are limited to the strain point of the glass end which is 515°C (959°F).

PRESSURE LIMITS

Ultra-high vacuum to 25 PSIG (170 kPa).

TESTING

All CAJON Glass/Metal Transition Tubes are 100% stress relieved and helium leak tested before leaving the factory.

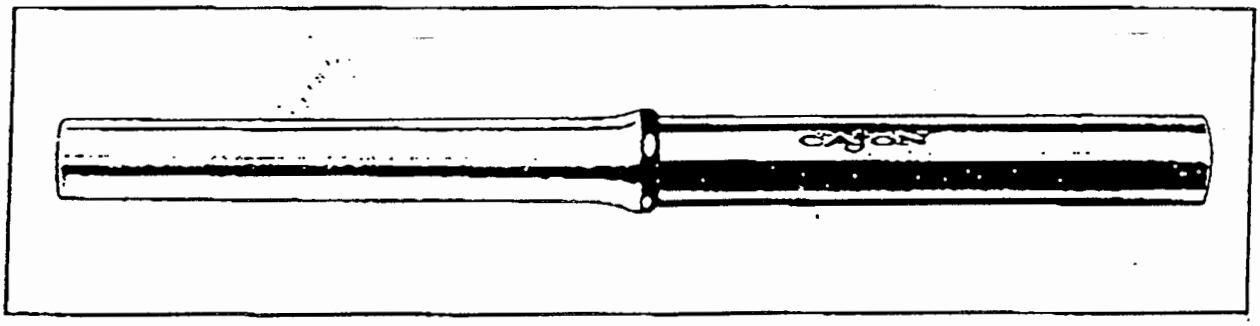
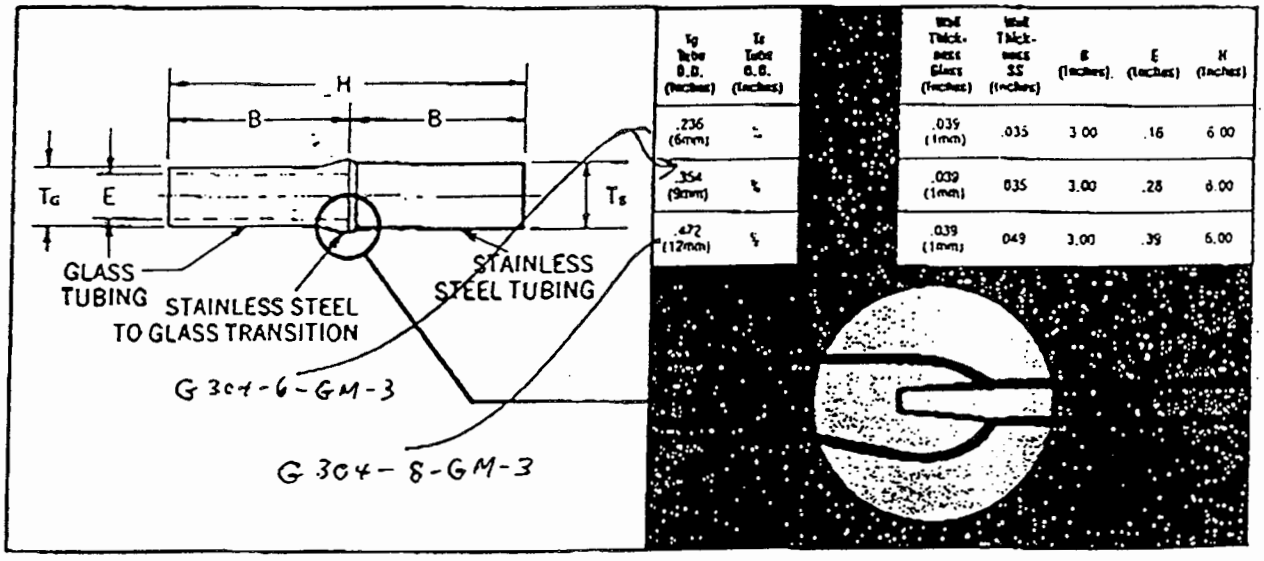


TABLE OF DIMENSIONS

G 304-4-GM-3



Tg Tube O.D. (Inches)	Ts Tube O.D. (Inches)	Wall Thickness Glass (Inches)	Wall Thickness SS (Inches)	B (Inches)	E (Inches)	H (Inches)
.236 (6mm)	¼	.039 (1mm)	.035	3.00	.16	6.00
.354 (9mm)	⅜	.039 (1mm)	.035	3.00	.28	6.00
.472 (12mm)	½	.039 (1mm)	.049	3.00	.39	6.00

$40 - $45 each

1987

Dimensions for reference only — subject to change.

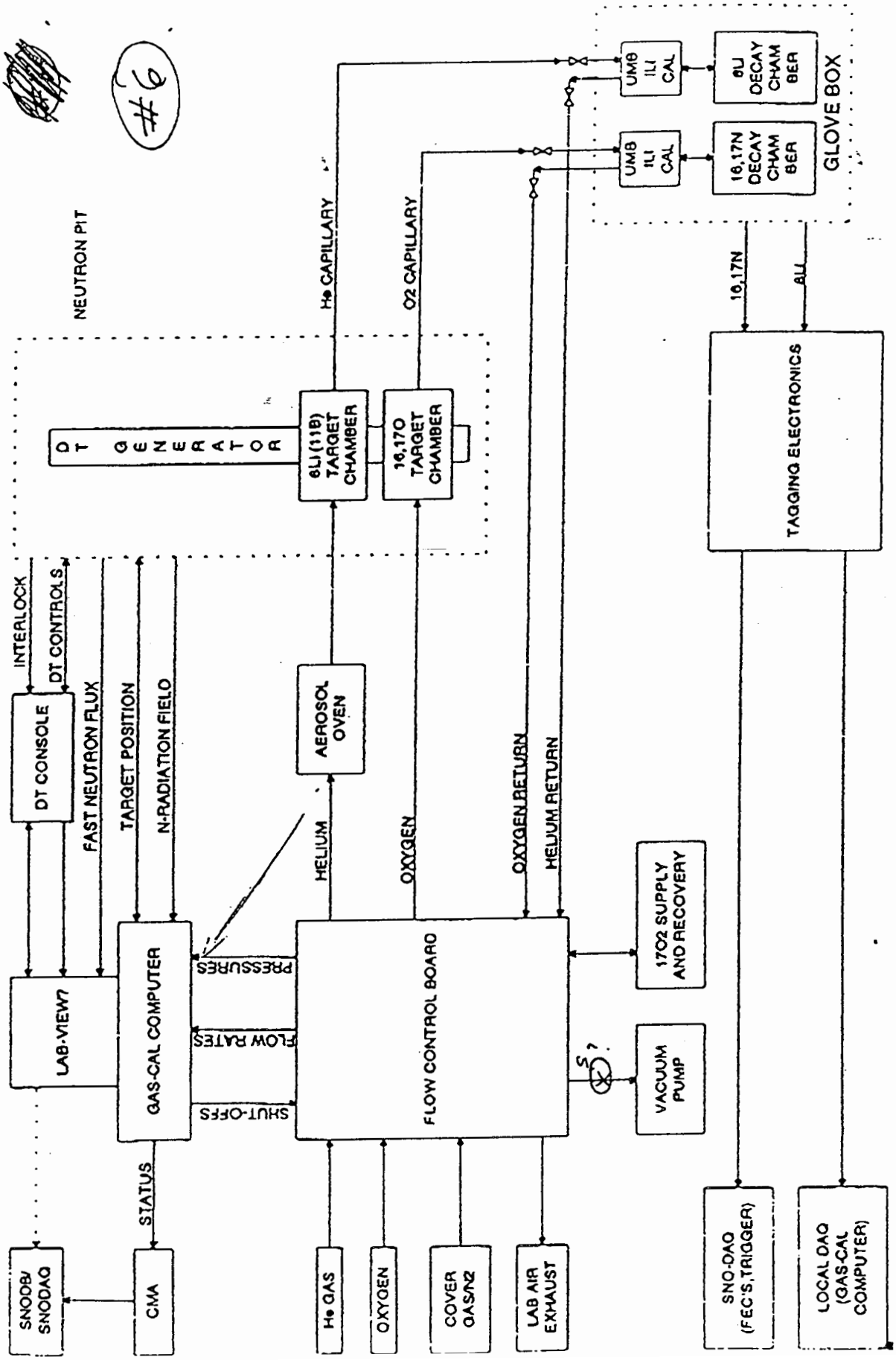
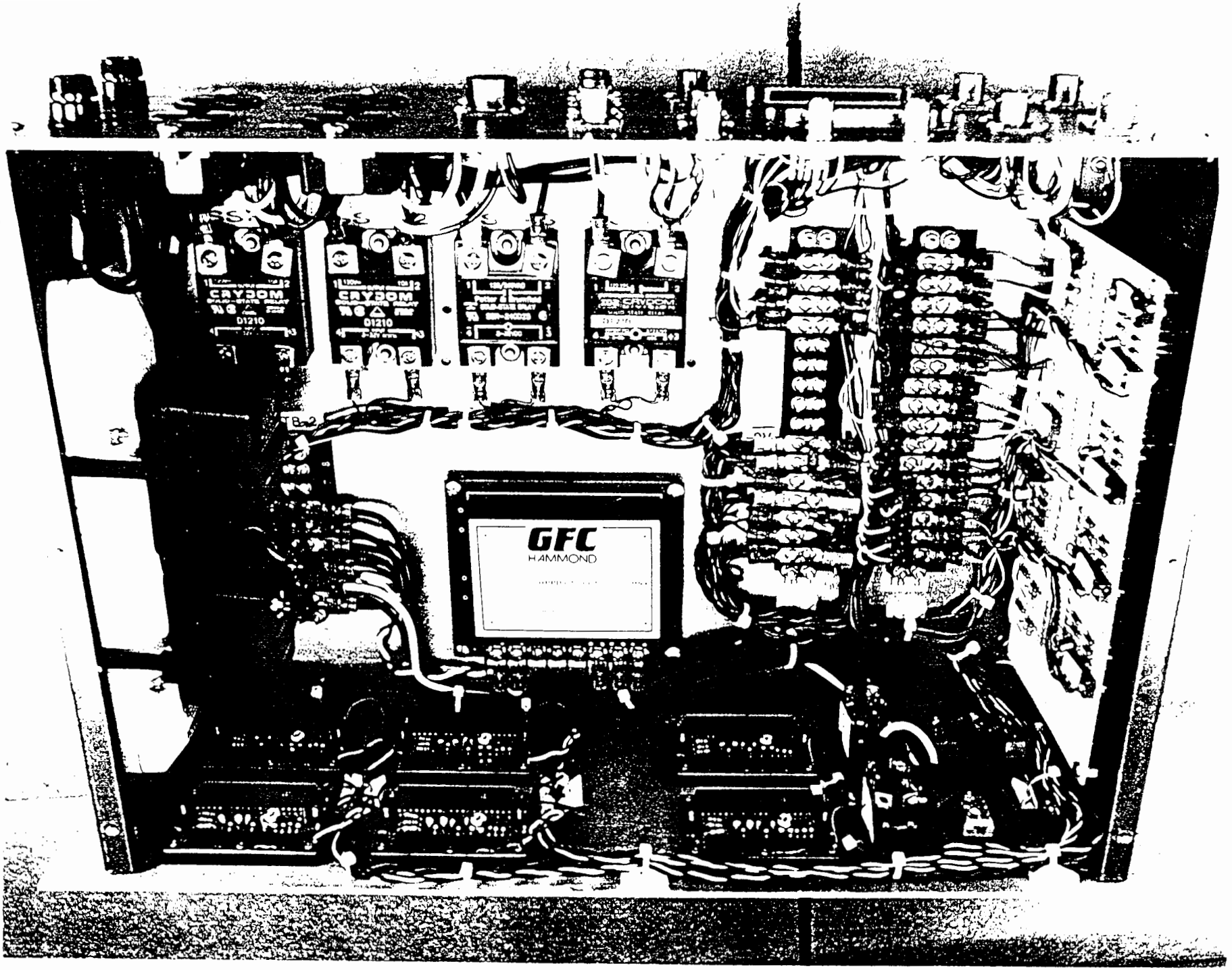


Figure 2: Schematic Connection Diagram for Gas Transport Calibration Sysytem

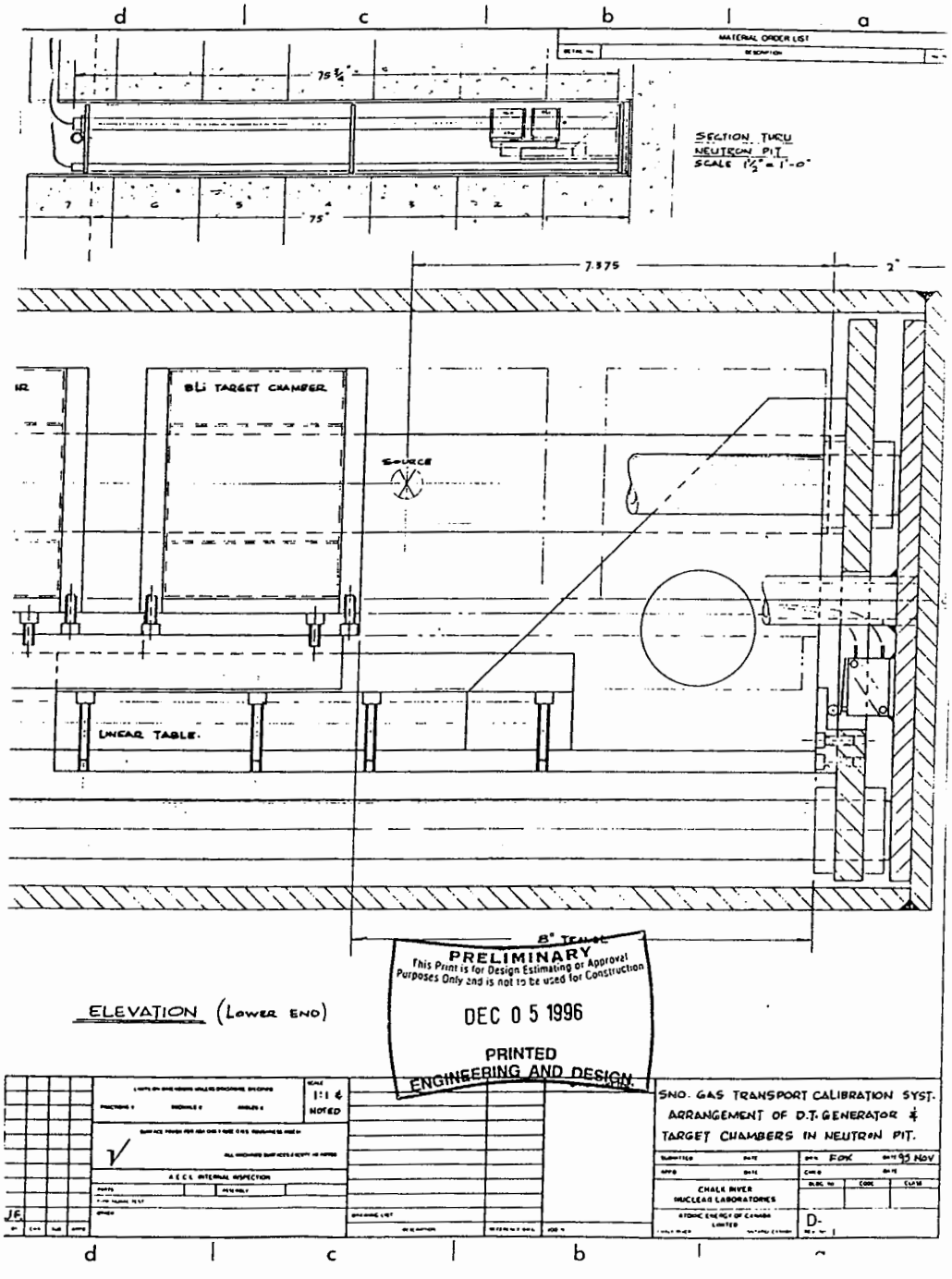

CRYDOM
D1210
CRYDOM
D1210
GFC
HAMMOND

DETAIL [illegible]

NOTES:

1. CONCRETE WORK TO BE IN ACCORDANCE WITH CAN 3-A 23.1 CONCRETE TO BE 25MPA, 3/4" MAXIMUM SIZE AGGREGATE.
2. REINFORCEMENT TO BE IN ACCORDANCE WITH CSA G 30. 12 M. GR 400 MPA.
3. ALL REINFORCING RODS MUST HAVE 1-1/2" COVER.
4. TOLERANCE : 1/4" FOR OUTSIDE CONCRETE
   : 1/8" FOR INSIDE CONCRETE
5. PAINT ON CONCRETE & EXPOSED LIFTING LUGS
   HIGH BUILD EXPOXY PAINT (100% SOLIDS)
   2 COATS WITH RECOMMENDED PRIMER AND SURFACE PREPARATION.
   COLOUR - WHITE
   THICKNESS - 6 MILS PER COAT.
   TOTAL THICKNESS = 12 MILS.
6. 4"x4" SLOT IN ST. STL. PIPE NEEDS ROUND EDGES

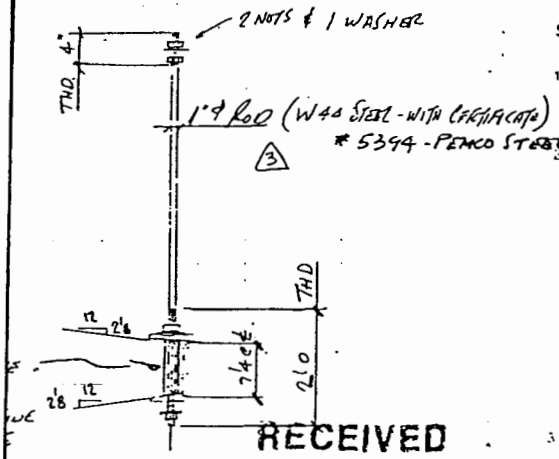
ATON MINE	ESKAY NO. SHO 86268	REV:
INO LABORATORY	17-702-E-7154	4
PIT (MODIFIED)		
IN BY G CONTE DATE OCT. 17, 1995		


d
c
b
a
MATERIAL ORDER LIST
SECTION THRU NEUTRON PIT
SCALE 1½" = 1'-0"
75 3/4"
75"
7.375
2"
8Li TARGET CHAMBER
SOURCE
LINEAR TABLE.
8" TYP.
ELEVATION (LOWER END)
PRELIMINARY
This Print is for Design Estimating or Approval Purposes Only and is not to be used for Construction
DEC 0 5 1996
PRINTED
ENGINEERING AND DESIGN
SNO. GAS TRANSPORT CALIBRATION SYST.
ARRANGEMENT OF D.T. GENERATOR & TARGET CHAMBERS IN NEUTRON PIT.
AECL INTERNAL INSPECTION
CHALK RIVER NUCLEAR LABORATORIES
ATOMIC ENERGY OF CANADA LIMITED
D.

4 | 4 | \ 4 - 5/8" ϕ HILTI - HVA x 8" L ADHESIVE ANCH'S

SECT. "C-C" (SHOWN)

SECT. "D-D" (SIMILAR - SEE PLAN)



STEELWORK — GENERAL NOTES

1. ALL STEELWORK SHALL BE FABRICATED AND ERECTED IN ACCORDANCE WITH CSA S16 OR CSA S16.1
   ALL WELDING SHALL CONFORM TO CSA W59
2. MATERIALS
   ALL ROLLED OR WELDED SHAPES SHALL CONFORM TO
   1) CANADIAN — CAN3 G40.21 - 300W
   2) U.S. — ASTM A36 FOR SECTIONS NOT MANUFACTURED IN CANADA
   STEEL PLATE
   STRUCTURAL — CAN3 G40.21 - 300W
   NONSTRUCTURAL — CAN3 G40.21-230G OR ASTM A283 GRADE C
   H.S. BOLTS (A325) 3/4" DIAMETER UNLESS NOTED
   HARDENED BEVEL WASHERS SHALL BE INSTALLED ON SLOPING FLANGES OF S OR C SHAPES
   WELDING ELECTRODES — E48018 (E7018)
3. CONNECTIONS
   SHOP: H.S. BOLTED OR WELDED
   FIELD: H.S. BOLTED
   ALL BOLTED CONNECTIONS SHALL BE BEARING TYPE UNLESS NOTED
4. PAINTING
   THE STEELWORK PAINT SYSTEM SHALL BE
   TOP COAT - HI-BUILD EPOXY CONFORMING TO THE REQUIREMENTS OF STANDARD
   COLOUR BLUE (A80) GLOSSY
   CLEAN TO SSPC - SP10
   PRIMER - ORGANIC ZINC CONTENT NOT LESS THAN 85 % BY WEIGHT.

D ENGINEERING LIMITED
ting Engineers
land Avenue
y, Ontario, P3E 1Y2
)674-8457 Fax(705)674-7839

REGISTERED PROFESSIONAL ENGINEER
11/09/95
A. T. ABRERA
PROVINCE OF ONTARIO

STEEL LIMITED

NICKEL CITY STEEL - JOB # 95-164

GHTON MINE	JOB NO: S.N.O. 86268	REV.
TRINO OBSERVATORY	17-702-E-A2280	3
TY ROOM - MEZZANINE FLR. EXTENSION		
DRAWN BY G. CONTE DATE NOV. 7 /95		

Trow 016449

COMPRESSIVE STRENGTH CYLINDER TEST REPORT

Sudbury Branch

RECEIVED FEB 28 1996

Trow Consulting Engineers Ltd.
1074 Webbwood Drive
Sudbury, Ontario P3C 3B7
Telephone: (705) 674-9681
Facsimile: (705) 674-8271

LAB NO.	TEST NO.	CYL NO.	DATE CAST	DATE RECEIVED IN LAB	DATE TESTED	* T.O.F.	DENSITY kg/m³	SPECIFIED 28 DAY STRENGTH	7 DAY STRENGTH MPa	28 DAY STRENGTH MPa	DAY STRENGTH MPa
1578		1	Feb. 19/96	Feb. 21/96	Feb. 26/96		2472	25 MPa	22.7		
1579		2	"	"	Mar. 18/96		2459	25 MPa			
1580		3	"	"	"		2461	25 MPa			

NOTE: SUFFIX "F" DENOTES FIELD CURED * TYPE OF FRACTURE - REQUIRED WHEN CYLINDER FAILS TO MEET SPECIFIED STRENGTH AT 28 DAYS

CONTRACTOR:	Candu Engineering		
PROJECT:	S.N.O.		
LOCATION OF STRUCTURE:	2nd pour - concrete doughnuts		
CONCRETE SUPPLIER:	Wevy		
CYLINDERS CAST BY:	P. Peltomaki	OF:	Pelto Consulting
TIME MIXER CHARGED:	n/a	TIME CYLINDER CAST:	1:15 p.m.
TYPE OF MOULD USED:	Plastic	MEASURED SLUMP:	n/r
TEMP. OF CONCRETE:	n/r	AIR TEMPERATURE	inside shop
SPECIFIED AIR %:	n/r	MEASURED AIR %:	n/r
WATER ADDED ON THE JOB:	no	BY WHAT AUTHORITY:	
TRUCK NO.:	n/r	LOAD NO:	n/r
NOM. SIZE OF AGG.:	n/r	DRUM COUNT REVS.:	n/r
TYPE OF ADMIXTURE:	n/r	AIR ENG. AGENT:	n/r
INITIAL 24 HOUR CURING TEMPERATURES:	MAXIMUM: n/r	MINIMUM:	n/r

Distribution
File # 051-50886

Person	Info	Action
LDM	✓	
DH		
RS		
SS		
VD		
AH		
EK	✓	

MATERIALS USED PER CUBIC METRE

CEMENT:	WATER
COARSE AGG.:	FINE AGG.:
NAME OF ADMIXTURE:	NAME OF AIR ENT. AGENT:

REMARKS:

WE HEREBY CERTIFY TESTING PROCEDURES IN ACCORDANCE WITH CAN3-A23.2M94 FOR THAT PORTION OF THE TESTING PERFORMED BY THIS COMPANY

DISTRIBUTION: Sudbury Neutrino Observatory - FAX: 692-7001
Pelto Consulting - Mr. P.A. Peltomaki

JOB NO. 300515R

7 DAY RESULTS

28 DAY RESULTS

___ DAY RESULTS

CSA CERTIFIED

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Wall Coating Information for the Nitrogen 16 Facility
Sudbury Neutrino Observatory Laboratory

E.D. Hallman, Laurentian University
P.H. Oliver, SNO

September 1996

SNO-STR-96-xxx

Introduction

The nitrogen (^{16}N) generator for calibration of the SNO detector is to be housed in a 4 ft diameter by 6.5 ft deep pit in the corridor junction section of the SNO laboratory. Since the base of this pit is close to the depth of a nearby sump (with an automatic pump operation), waterproofing measures were completed to ensure that the pit would remain dry at all times. This report describes the coating materials used, their installation, and operations experience over the 6 months since the work was completed.

Coating Materials and Installation

The pit is formed from two sections of 4 ft diameter concrete pipe, with a 6 inch thick poured concrete floor. Two years ago, the walls had been coated with a layer of epoxy paint. Some water seepage was observed in the pit, when water levels in the nearby sump were less than 1 ft below the floor of the pit. Subsequently, the nearby sump was deepened to about 2 ft below the pit and a sump pump, with automatic operation when water levels reached 1.5 ft below the pit, was installed. A polyurethane coating system supplied by Normac Adhesive Products Inc. was applied to the walls and floor of the pit, to provide a water seal for the pit, regardless of water levels in the sump. Specifications for the 2 main components of this system - grout and wall coat - are given in Appendix 1.

One day prior to the coating work, the pit was cleaned and dried out using fans, and the water level kept low in the nearby sump. For the floor joint and the top joint between the pipe and a steel cover flange, *Normac 900R primer* was applied to the cleaned and sanded concrete/epoxy paint surface. *Normac BR-5T trowelable polyurethane grout* was mixed (3 parts A to 1 part B) and installed in the 90° joint at the floor, (3/4 inch wide bevelled form), and over the rough joint to the steel flange at the top. All surface holes in the concrete greater than 1/8 inch in size were also filled with this grout material, which sets in about 1 hour, and is highly thixotropic (no flow from vertical

layers was observed). After the grout had set, a layer of *Normac NR-5S 400 polyurethane coating* was applied by hand with paint rollers and brushes. For the 80 sq.ft. surface, the 1.5 gallons used (in a mix with 2 parts Part A to 1 part Part B) provided a coating of approximate thickness 1/32 inch (30 mil). Because isocyanate emissions occur during the application, air supply respirators were worn and an exclusion zone near the pit was established (see the report included in Appendix 2).

After the first coat was applied, several bubbles were discovered in the joint at the floor - if water is present, the grout tends to foam and raise from the surface as setting occurs. Three sections of the bevelled grout (totalling about 3 ft) were removed, the area was well dried, and new grout was installed. In total, 4 layers of the polyurethane coat were installed, giving a total thickness close to 1/8 inch. Between coats, any runs were planed smooth and pin holes sealed with the grout. Since the coating work was completed (April 2, 1996) regular inspections have shown the pit to remain dry even when water levels in the sump nearby are comparable to the floor level of the pit. A 1 inch high ring, sealed to the top flange with silicone adhesive, was subsequently added to prevent water spilled on the junction room floor from entering the pit. No change in the sealing was observed when the concrete shielding rings (filling the pit except for a central 1 ft diameter hole) were installed in June 1996. Given the successful sealing of this pit, the Normac coatings have been adopted for hand-applied repair work in the SNO detector cavity, where a sprayed-on polyurethane wall coating (from Urylon Plastics Inc.) is in place. The Normac coating is less tough than the Urylon coat, but it is easy to apply and satisfactory in areas where impact or abrasion are not encountered.

Appendix 1: Wall Coating Material Specifications (Normac Adhesive Products Inc.)

BR-5T - Rev. 0

NORMAC® BR-5T PHYSICAL DATA

Product Name:	BR-5T Trowelable Grade Urethane		
Material:	Polyester TD1 Elastomer		
Mix Ratio:		PART A*	PART B
	Weight:	100	33.3
Pack Size:	Kit	PART A	PART B
	1/4 litre	187.5 gms	62.5 gms
	1/2 litre	375 gms	125 gms
	1 litre	750 gms	250 gms

*May solidify upon prolonged standing at low temperatures

TYPICAL PHYSICAL DATA VALUES

Application Life:	1 hour @ 21°C
Tack Free Time:	3 hour @ 21°C
Hardness:	73 Shore A
Bashore Resilence:	41% (ASTM D2632)
Flexibility:	Pass ¼" conical mandrel (ASTM D522)
Modulus @ 300% psi:	745 (ASTM D412)
Tensile Strength, psi:	2025 (ASTM D412)
Elongation %:	540 (ASTM D412)

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APPLICATION PROCEDURES

NORMAC®

BR-5T

BR-5T trowellable grade polyurethane is a new maintenance item which can be utilized in the repair of rubberlike components, without the need of cumbersome rubber curing equipment.

BR-5T is an elastomeric polymer, that when mixed in proper portions, will yield a tough rubbery compound with exceptional abrasion and tear resistance. Typical uses for BR-5T are conveyor belt repairs, rubber repairs and off-road tire repairs.

BR-5T comes in convenient pre-weighed containers, that when mixed thoroughly, can be applied in any thickness without the risk of shrinkage, due to the absence of volatile solvents. The cured repair can be machined or buffed to a smooth finish.

APPLICATION

The areas to be repaired should be thoroughly cleaned in preparation for patching. The following procedures is recommended.

1. Wash the patch area and scrub with a wire brush to loosen and remove surface contaminants, such as dirt or particles, wood chips, etc.

2. Remove loose particles with a clean rag or blow air from a compressed air gun across the surface.

3. Wipe the surface of the patch area with a rag soaked in toluene (toluol), or suitable solvent, This is to remove any olly contaminants which may be in the repair area. Now remove any excess solvent with a clean dry rag.

4. The repair area must now be buffed with a disc grinder, or wire wheel to freshen up the rubber surface. Feather any sharp, exposed edges.

5. If steel is exposed it should be sandblasted or ground with a disc grinder before a suitable primer is applied.

6. Other than available urethane chloroprene cements, such as Normac 900R will give a good bond to rubber or urethane.

7. After the second coat of adhesive is applied, the mixing of the BR-3T may commence.

8. Calculate the volume in the repair area, and weigh out the required portions of Part "A" and "B" of the BR-5T. 375 gms. of Part "A" and 125 gms. of Part "B" will displace 25 cubic inches or approximately 400 cubic centimeters.

NORMAC®

NR-5S 400 PHYSICAL DATA

Product Name: NR-5S 400 Part "A" and Part "B"

Product Description: A 100% solids urethane coating designed for application by brush or roller.

Material: 100% Solids - Aliphatic polyether urethane based coating

Mix Ratio:

	Part "A"	Part "B"	Part "C"* (Optional)
Weight:	100	50	1.33
Volume:	100	50	0.76

*Optional: Part "C" refers to colour only. The amounts indicated are to be added to the mixed "A" and "B" clear, only when you are using approved colourants.

Pack Size:

Kit	Part "A"	Part "B"
4 litre (gal.)	4.55 kg. (10.0 lbs.)	2.27 kg. (5.0 lbs.)
20 litre (5 gal.)	9.09 kg. (20.0 lbs.)	4.55 kg. (10.0 lbs.)

TYPICAL PHYSICAL DATA VALUES

Application Life: 30 to 45 minutes @ 21°C (70°F)

Tack Free: 1¼ to 2 hrs. @ 21°C (70°F)

Print Free: 3 to 4 hours @ 21°C (70°F)

Hardness: 92-94 Shore A

Bashore Resilience: 40% (ASTM D2632)

Impact Resistance: Greater than 160 in./lbs. (ASTM D2794)

Tear Strength: 363 lb f/in. Die C (ASTM D-624)

NORMAC®

NR-5S 400 PHYSICAL DATA

Tensile Strength:	3825 psi (ASTM D412) - Method A
Elongation:	302% (ASTM D412) - Method A
Abrasion Resistance:	0.0017 grams weight loss per 1000 cycles, H22 wheel, at 1000 gms. (ASTM D1-044)
Operating Temperature:	-56°C (-70°F) to 93°C (200°F)
Fungus Resistance:	Non-nutrient
Weight of Cured Coating:	44 gm./m² @ 25 microns 0.90 lbs. per 100 ft.² at .001" thick
Modulus 100%:	1380 psi (ASTM D412)
Ultimate Cure:	5 days at 30 dry mils at 70°F
Recoat Times:	Minimum: 60 - 90 minutes Maximum: 72 hours
Volatile Organic Compound (V.O.C.):	0% V.O.C. - as material is 100% solids, 100% reactive.
Mixed Solids Content:	100%
Flash Point:	Greater than 100°C. See MSDS.
Application:	Normac NR-5S 400 can be dipped, brushed, sprayed or rolled. For brushing - use a natural bristled paint brush. Allow the NR-5S 400 to become tack-free before applying second and successive coats. Build rate per coat will vary depending on the substrate. For vertical surfaces 0,2mm to 0,3mm (.008" to 012") will be the maximum build. For roller or power roller coating use a short napped roller as this will reduce the amount of roller hairs left in the coating. Build per coat can be as high as 0,4 to 0,5mm (.016" to .020").

Appendix 2:

MEMORANDUM

To: J. Fitzgerald
L. Moriarty
D. Hepburn
N. Bodson
B. Robertson
K. Langille
G. Morbin
P. Oliver
R. Price
G. St. Louis

From: D. Hallman
Date: September 26, 1995
Re; N-16 Pit Coating Procedure

NORMAC POLYURETHANE COATING PROCEDURE N-16 PIT, SNO LABORATORY

E.D. Hallman, Laurentian University

(minutes of the Fail Safe Meeting - August 30, 1995)
(Attending: Norm Bodson, Doug Hallman, Ken Langille, George Morbin, Larry Moriarty, Doug O'Connor, Phil Oliver, Barry Robertson.)

The N-16 pit is a 6 ft 6 inches deep by 4 ft diameter concrete pipe with a 6 inch concrete floor, installed below laboratory floor level just outside the entrance to the SNO Utility Room. It is to be coated with a waterproof layer prior to the installation of shielding rings and the N-16 generator (for detector calibration). It was agreed that the material chosen for patching the Urylon cavity liner - NORMAC NR-5S 400 polyurethane - be used in the pit, to further test application procedures and the coating prior to its use in the cavity. Since one of the two-components of this polyurethane product contains isocyanates, special precautions are required during its application.

Materials and Delivery to the Site

For a 0.125 (1/8) inch thick coating of the 80 sq ft surface of the pit, 6 gallons of NR-5S 400 is required. The coating will be applied with rollers and brushes. The two components will be delivered underground in their original shipping containers inside a specially marked SNO 'blue box'. A spill kit consisting of an empty 5 gallon container. rags and scoops, will also be included. Any waste materials after the coating process will be packaged and returned to surface in the blue box, and disposed of by SNO.

Application Procedures

1. Rubber gloves, Tyvek suits and full face air supply respirators are to be worn by the coating personnel and any assistants near the application site.

2. The components will be mixed on a table near the site (by weight).

3. Air monitoring carried out during a previous test of this material in the laboratory (March 1995 - report attached), indicates levels of HDA (an isocyanate component) well below the TLV at 5 m from the application point (in the deck area). Thus, an exclusion zone, marked with ropes and signs will be set up to include most of the junction room area, except for a narrow corridor to permit personnel to move along the air handler # 2 side, from the personnel area to the control room. This application will be done on a shift when no work is planned for the utility room. Exhaust air from the site moves through the junction to the car wash and out of the laboratory. A small, diluted fraction of exhaust air may be recirculated into the SNO lab, once the exhaust reaches the laboratory entry gate (in the mine drift).

4. Since the pit is a 'confined space', all Ministry of Labour requirements for work in the pit will be followed. In particular, any applicators will wear full air supply respirators, and full body harnesses, and there will be a manual hoist (using an hitch installed on the mezzanine above) available for emergency escape use). A guard will be posted near the pit when application is in process.

5. The crew will include two applicators, a guard and a monitor for the air supply equipment, all having air supply respirators.

6. Two monitoring sites will be set up, one at the edge of the pit, and a second at the car wash entry door (clean room side), to check air quality during the application.

7. Any lighting within two meters of the site will be of explosion-proof type. Two fire extinguishers are to be located nearby.

8. The coating will be applied in a minimum of three layers, white, gray and white. each layer up to 25 mils in thickness. At the bottom joint between pipe and floor. a thicker (more thixotropic) grout mixture of this product will be trowelled on to bevel the joint and minimize the possibility of cracking. It may be necessary to allow part of the coating to set (about one hour), prior to finishing the rest, given the confined surface being coated. It is planned that two coats be applied per 8 hour shift, so that two shifts will be required.

9. An inspection of the pit will be carried out to see if any concrete repair is required, at least one week ahead of the coating work. The pit will be dried out with a ventilator fan, with the pit cover removed (guard installed), one week prior to the application.

10. Scheduled time for application - during the week of October 2 - 6, 1995. The level foreman will be notified of this work and its schedule.

Action Items

a)	safety signs, supplies, air supply equipment, ladder lighting	- George Morbin
b)	scheduling of work, arranging for hitch	- Larry Moriarty
c)	ordering of materials, application equipment MSDS information	- Doug Hallman
d)	scheduling of monitoring (Derek Erickson)	- Doug Hallman
e)	review of procedures	- Ken Langille - Doug O'Connor

Appendix: Procedure for repair of cavity wall (at platform cable 6 spreader bar)

A 5 cm long gouge in the Urylon cavity liner will be repaired by the end of September with the following procedure:

1. Patch area will be reached by a worker on the SNO bosun's chair (mounted through cable deck opening) from an access point on the acrylic vessel scaffolding tower.
2. Since only about 100 mL of material is needed, the NR-5S-400 components will be taken to the site by hand (D. Hallman) in containers enclosed in a gallon pail. From air levels of HDA, measured in the previous test, it is clear that air levels for this small amount will be far below the Time Weighted Average Exposure criterion (TWAEC). A chemical full face respirator could be worn by the applicator. Rubber gloves are required and a second container (containing the aluminum mixing tray for the patch) will be fastened to the bosun's chair.
3. The two components will be measured (with an electronic balance) and mixed in the deck area. The patch will be applied with a brush, after any protruding material near the gouge is cut flat, and the surrounding surface roughened with a rasp. Overlap with surrounding Urylon should be 5 cm or more. Two or three coats may be required to build up the gouge area to the height of the surrounding Urylon. A set time of about 45 minutes between coats is required.