On the water for filling and draining procedures for the IEA-R1 beam holes

Walmir M. Torres , Pedro E. Umbehaun , Miguel M. Neto ,

Altair A. Faloppa and Haruyuki Otomo (Nuclear Engineering Center)

Walter Ricci, Antonio L. Pires, Alberto J. Fernando

and Jose R. Berretta (Reactor Operation)

Ricardo N. Carvalho and Eduardo Y. Toyoda (Radioprotection Service)

IEA-R1 Nuclear Research Reactor

Power : 5 MW (design) – Babcock & Wilcox Company

First criticality : 1957

Type : open pool with downflow

Fuel Element : MTR low enrichment (19.7% U-235)

Active Core (5x5): 20 FE's with 18 fuel plates U-Alx + 4 CFE's

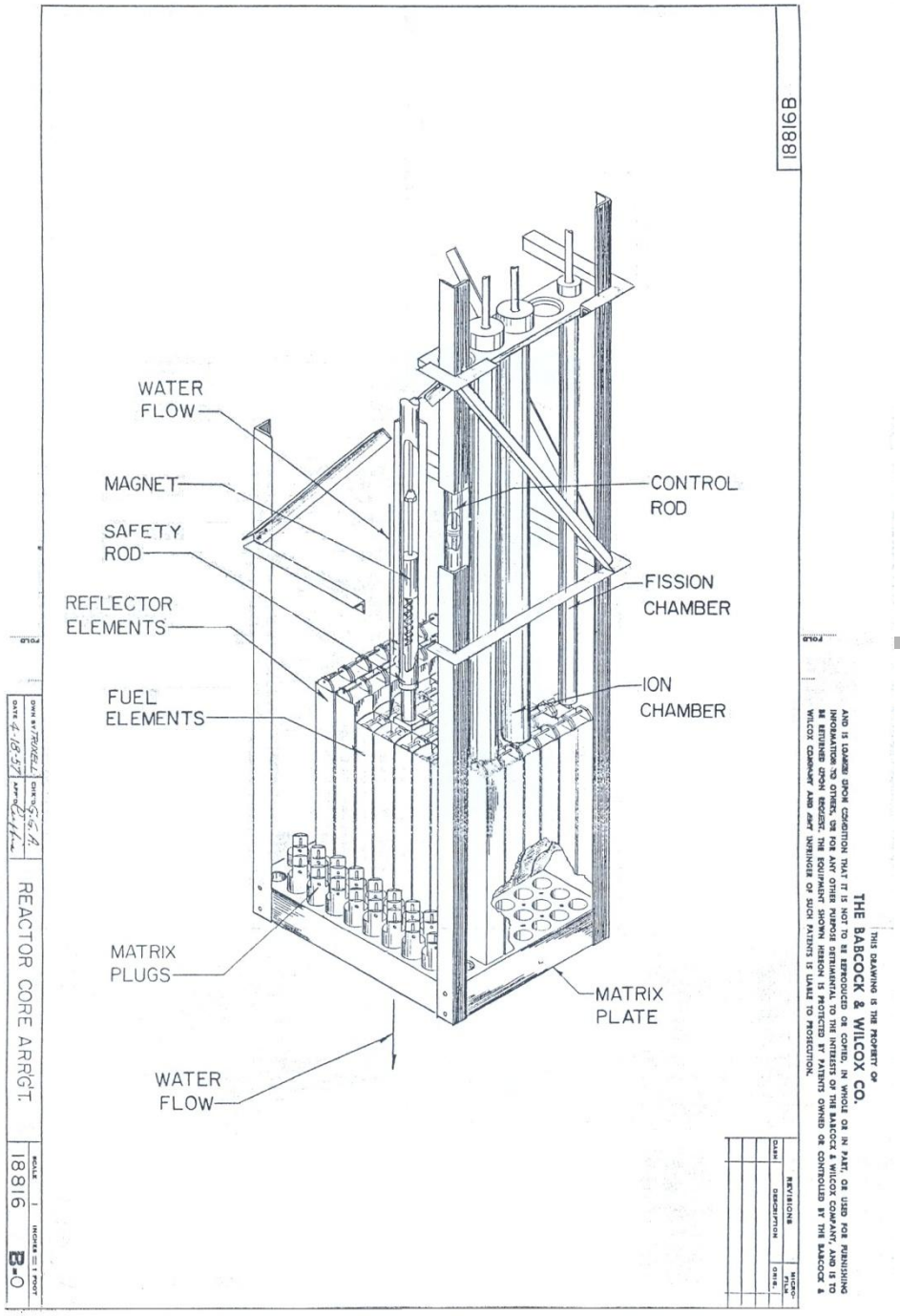
Control Fuel Element (CFE) : Ag-In-Cd with 12 fuel plates

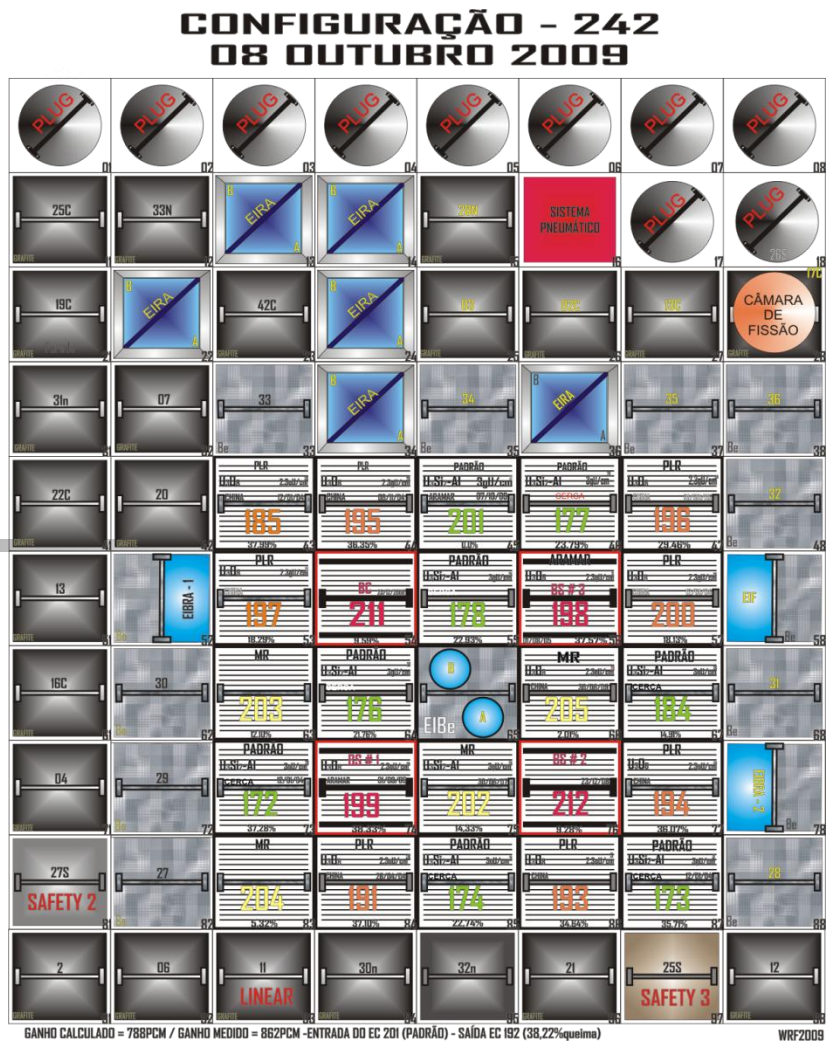
Reflector Elements : Berilium and Graphite

In-core Irradiation devices : Berilium and water boxes

Beam holes : 14 (12 radial and two tangential)

Operation Rate : 64 hours a week at 4.5 MW


18816B
WATER FLOW
MAGNET
SAFETY ROD
REFLECTOR ELEMENTS
FUEL ELEMENTS
MATRIX PLUGS
WATER FLOW
CONTROL ROD
FISSION CHAMBER
ION CHAMBER
MATRIX PLATE
REACTOR CORE ARRGT.
18816
THE BABCOCK & WILCOX CO.


CONFIGURAÇÃO - 242
08 OUTUBRO 2009
PLUG
EIRA
SISTEMA PNEUMÁTICO
CÂMARA DE FISSÃO
SAFETY 2
SAFETY 3
LINEAR
GANHO CALCULADO = 788PCM / GANHO MEDIDO = 862PCM -ENTRADA DO EC 201 (PADRÃO) - SAÍDA EC 192 (38,22%queima)
WRF2009

IEA-R1 CORE

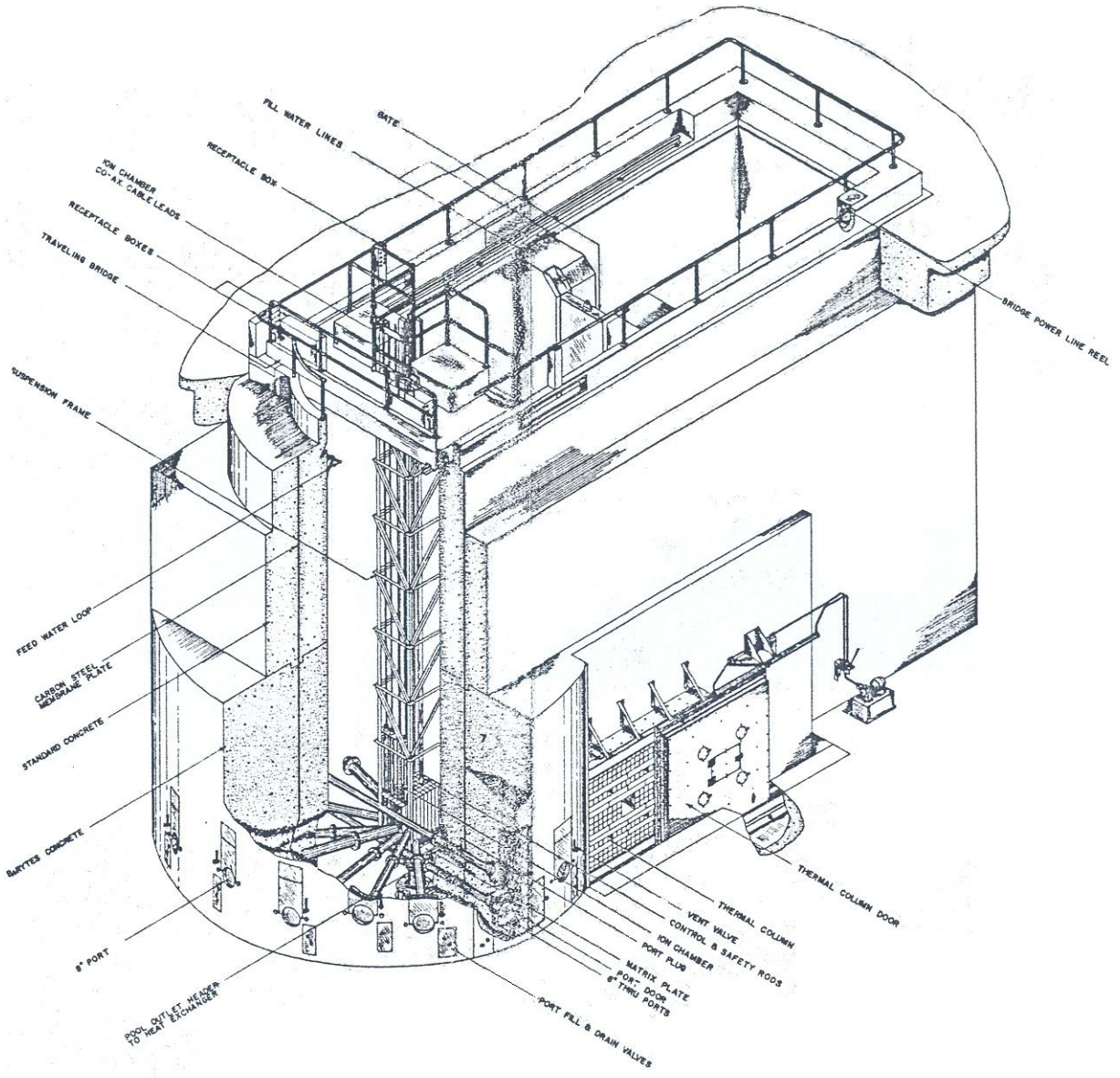
IEA-R1 Nuclear Research Reactor Utilization

Radiosotope Production (In-core Irradiation Devices)

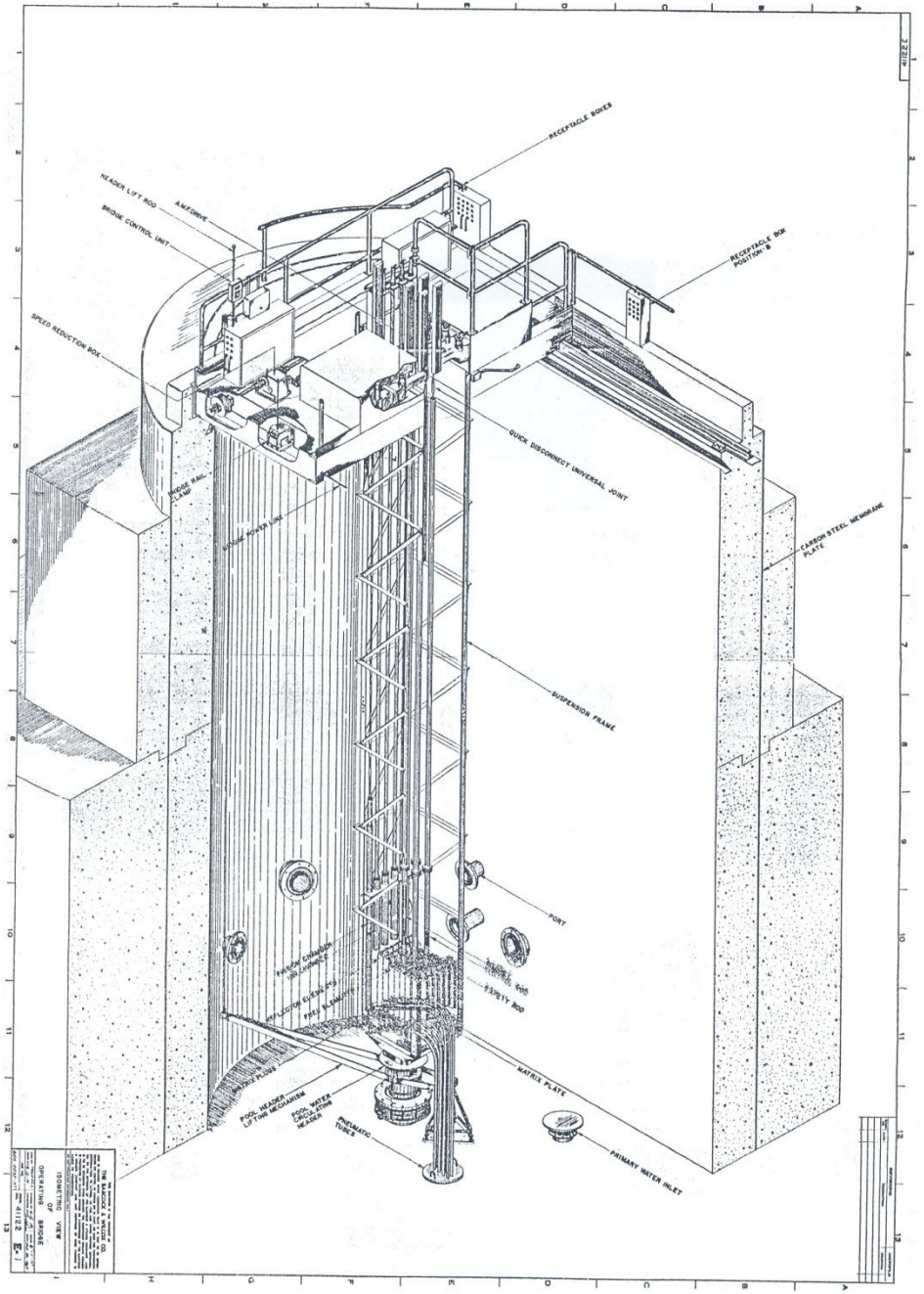
1. **Sm-153 for bone metastasis and arthritis treatment;**
2. **I-131 for Thyroid cancer treatment and diagnosis;**
3. **Ir-192 (seeds) for brachytherapy;**
4. **Co-60 sources for gammagraphie;**
5. **Br-82 radioative tracers; and others.**

Researches and Experiments (BHs and Pneumatic System)

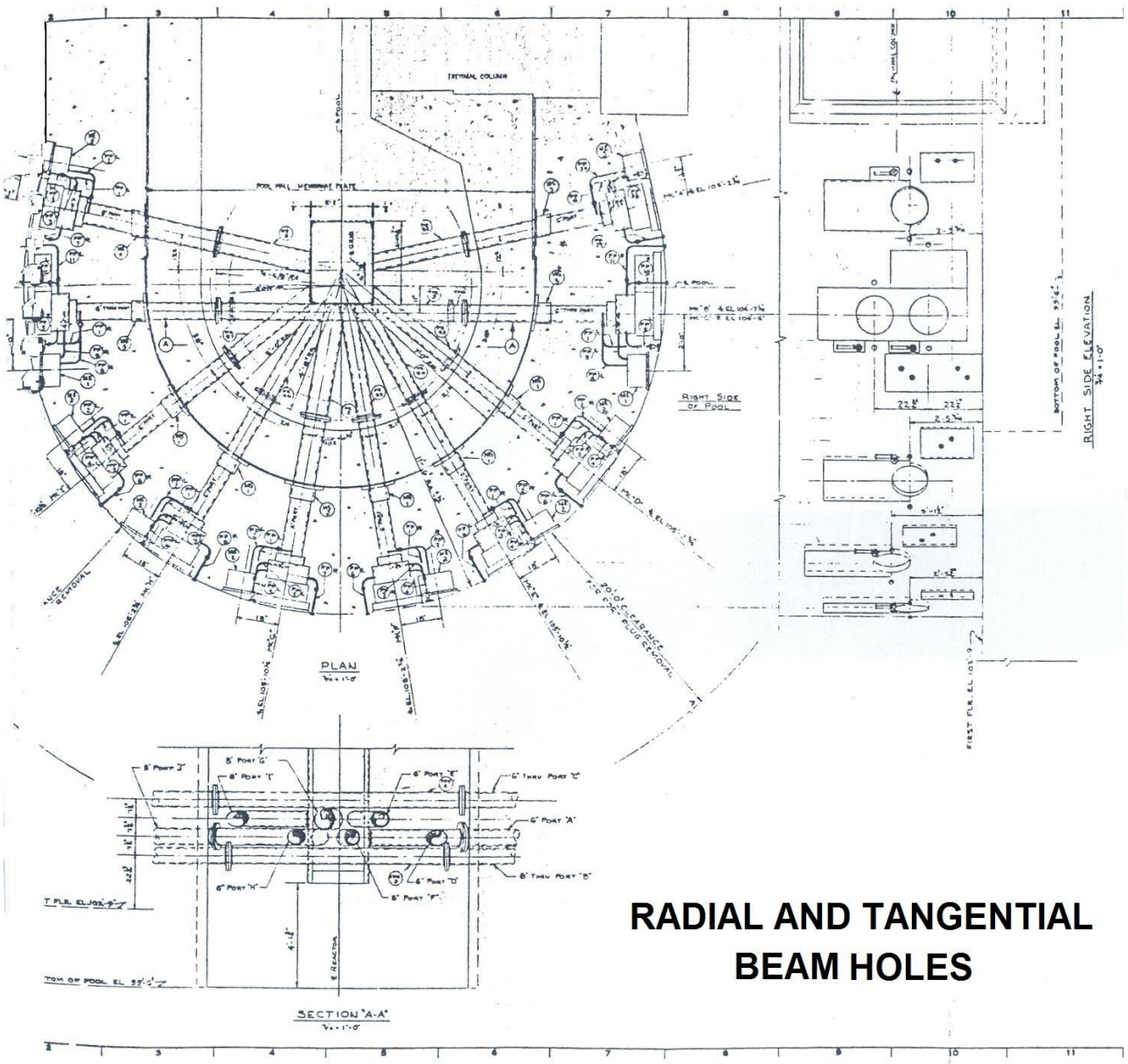
1. **Activation Analysis - Pneumatic System**
2. **BNCT (Boron Neutron Capture Therapy) – BH3**
3. **Neutrongraphy Studies – BH8**
4. **Neutron Difraction Studies– BH6**
5. **Prompt Neutron Analysis – BH12**



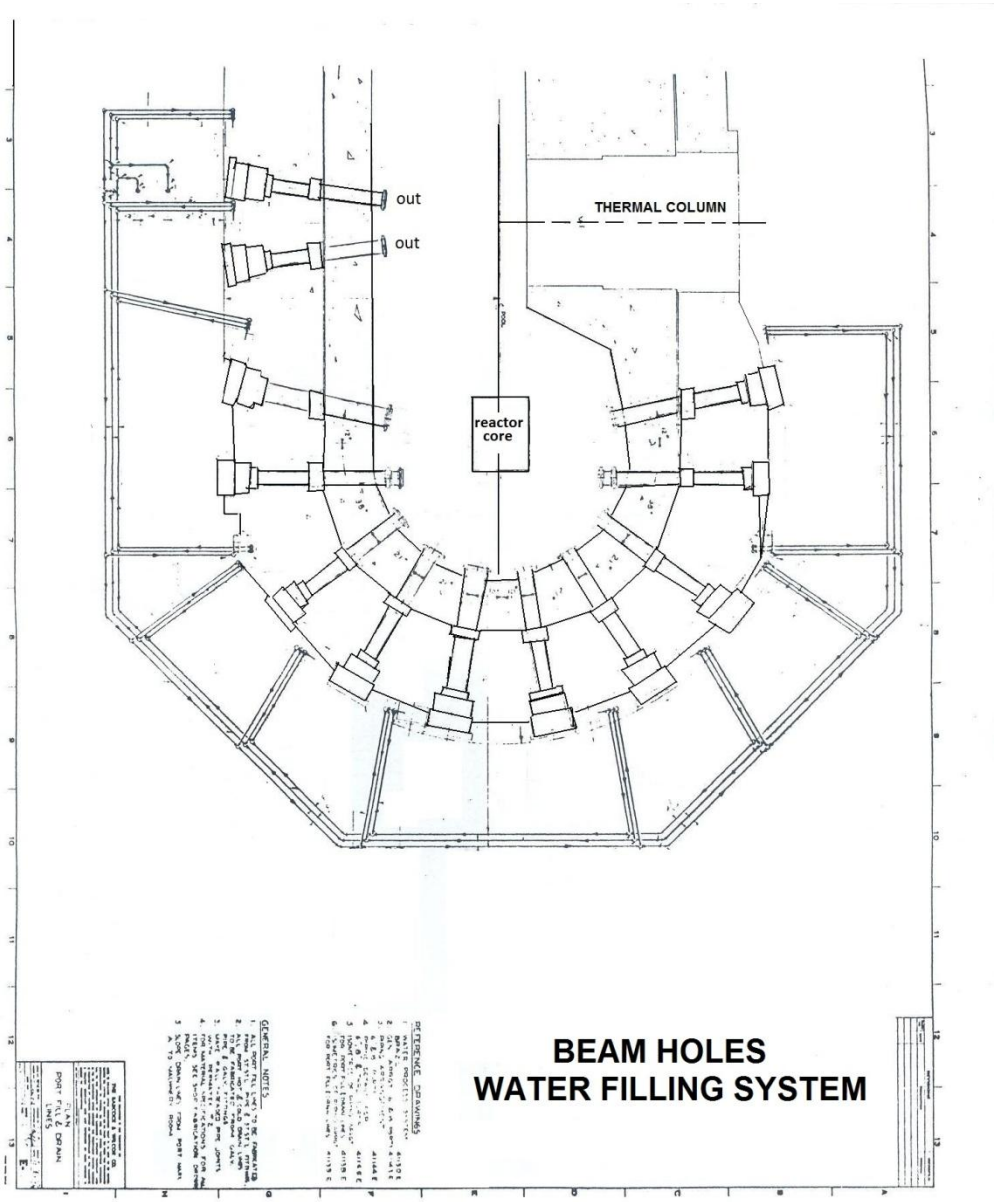
Reactor pool overview, core, suspension frame and beam holes



Reactor pool , core, suspension frame, pneumatic system, and beam hole flanges



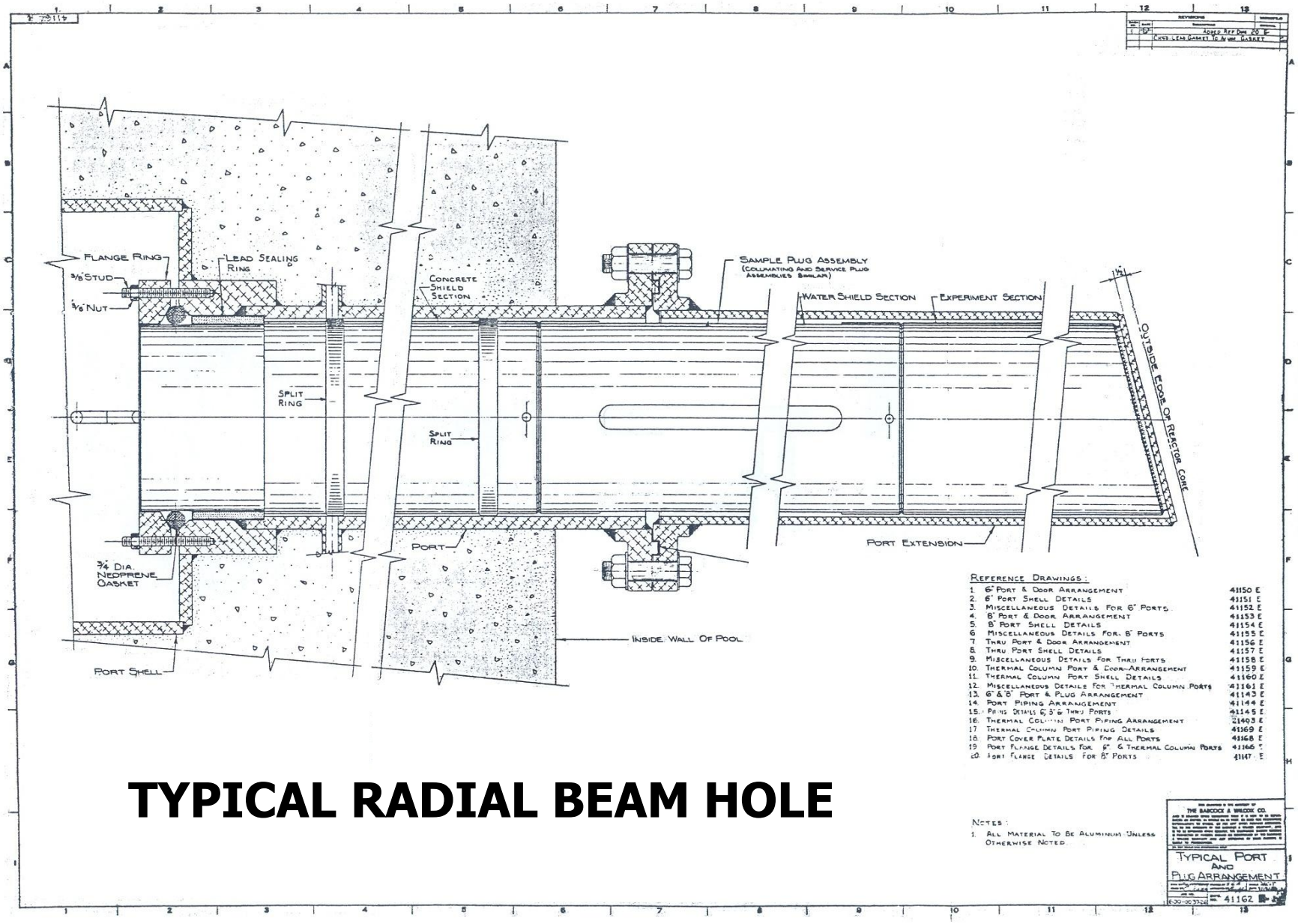
RADIAL AND TANGENTIAL BEAM HOLES


out
out
THERMAL COLUMN
reactor core
BEAM HOLES
WATER FILLING SYSTEM

BEAM HOLES – PROBLEMS AND SOLUTIONS

PROBLEM 1 : In 1998, during the FINAL SAFETY ANALYSIS REPORT (FSAR) review, it was observed that there was a possibility of LOCA through BH's in case of liner rupture .

SOLUTION 1 : The solution to avoid this accident was the installation of a "hat" (internal or external) at the inlet of each BH.



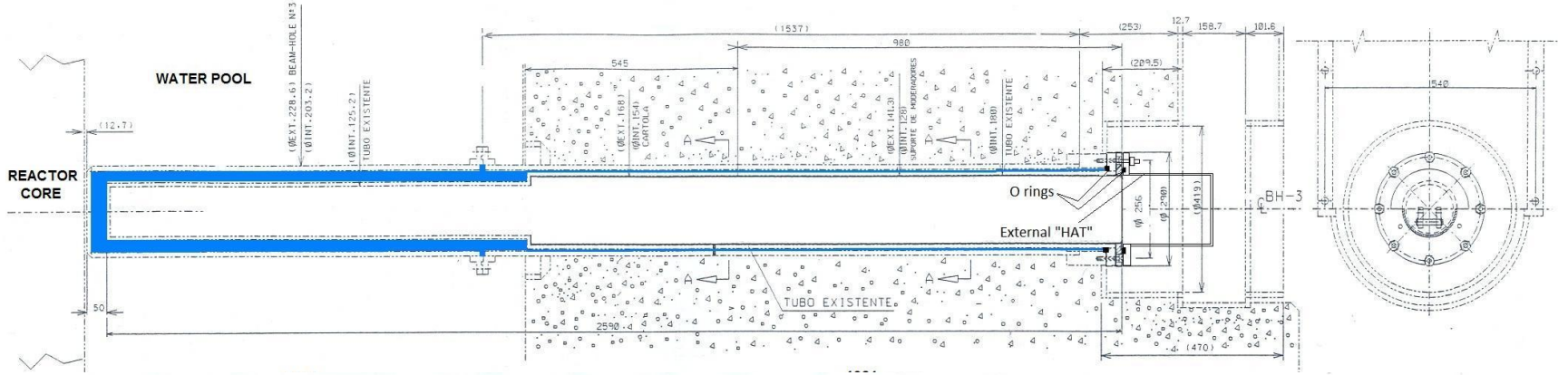
TYPICAL RADIAL BEAM HOLE

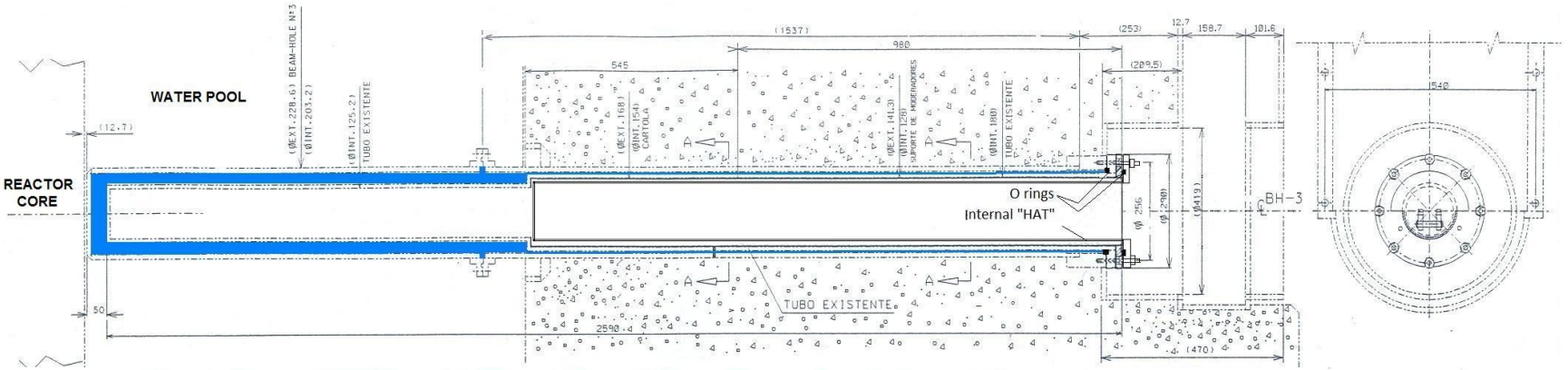
REFERENCE DRAWINGS:

1.	6" PORT & DOOR ARRANGEMENT	41150 E
2.	6" PORT SHELL DETAILS	41151 E
3.	MISCELLANEOUS DETAILS FOR 6" PORTS	41152 E
4.	8" PORT & DOOR ARRANGEMENT	41153 E
5.	8" PORT SHELL DETAILS	41154 E
6.	MISCELLANEOUS DETAILS FOR 8" PORTS	41155 E
7.	THRU PORT & DOOR ARRANGEMENT	41156 E
8.	THRU PORT SHELL DETAILS	41157 E
9.	MISCELLANEOUS DETAILS FOR THRU PORTS	41158 E
10.	THERMAL COLUMN PORT & DOOR ARRANGEMENT	41159 E
11.	THERMAL COLUMN PORT SHELL DETAILS	41160 E
12.	MISCELLANEOUS DETAILS FOR THERMAL COLUMN PORTS	41161 E
13.	6" & 8" PORT & PLUG ARRANGEMENT	41143 E
14.	PORT PIPING ARRANGEMENT	41144 E
15.	PIPING DETAILS 6, 5" & THRU PORTS	41145 E
16.	THERMAL COLUMN PORT PIPING ARRANGEMENT	21403 E
17.	THERMAL COLUMN PORT PIPING DETAILS	41169 E
18.	PORT COVER PLATE DETAILS FOR ALL PORTS	41168 E
19.	PORT FLANGE DETAILS FOR 6" & THERMAL COLUMN PORTS	41166 E
20.	PORT FLANGE DETAILS FOR 8" PORTS	41147 E

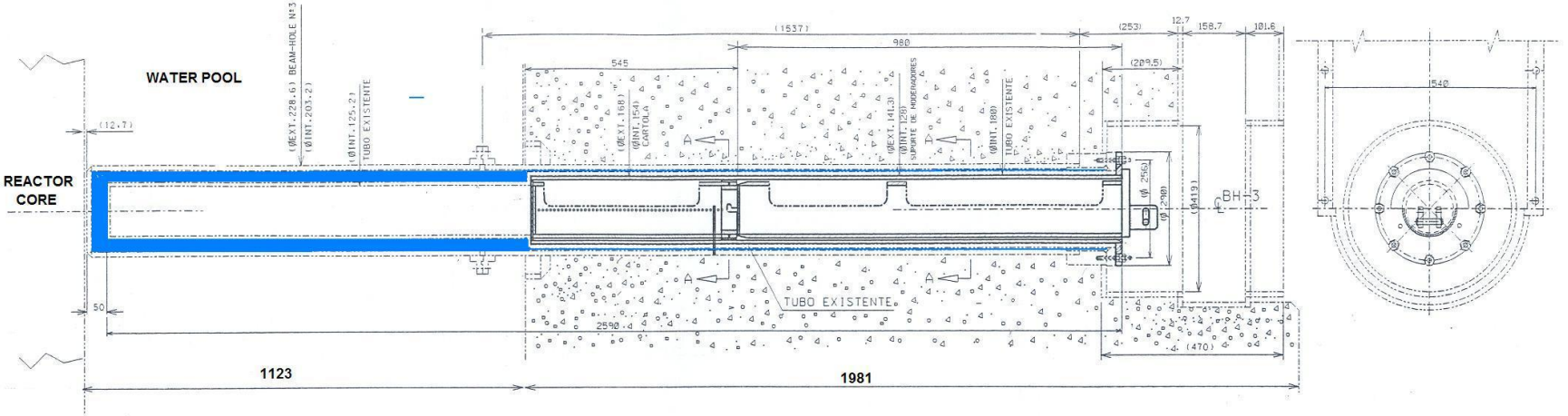
NOTES:
1. ALL MATERIAL TO BE ALUMINUM UNLESS OTHERWISE NOTED.

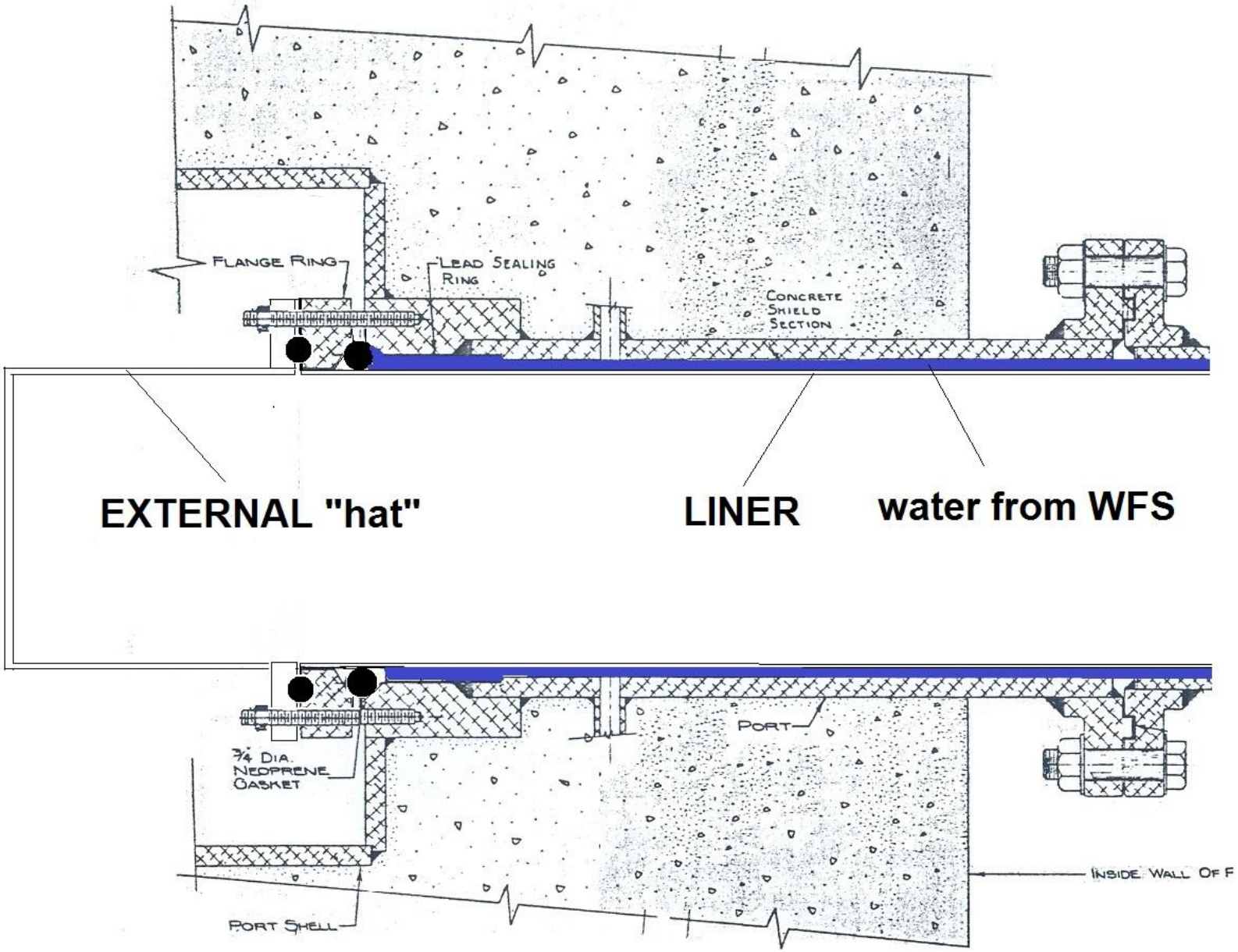
THE BABCOCK & WILCOX CO.
TYPICAL PORT AND PLUG ARRANGEMENT
41162



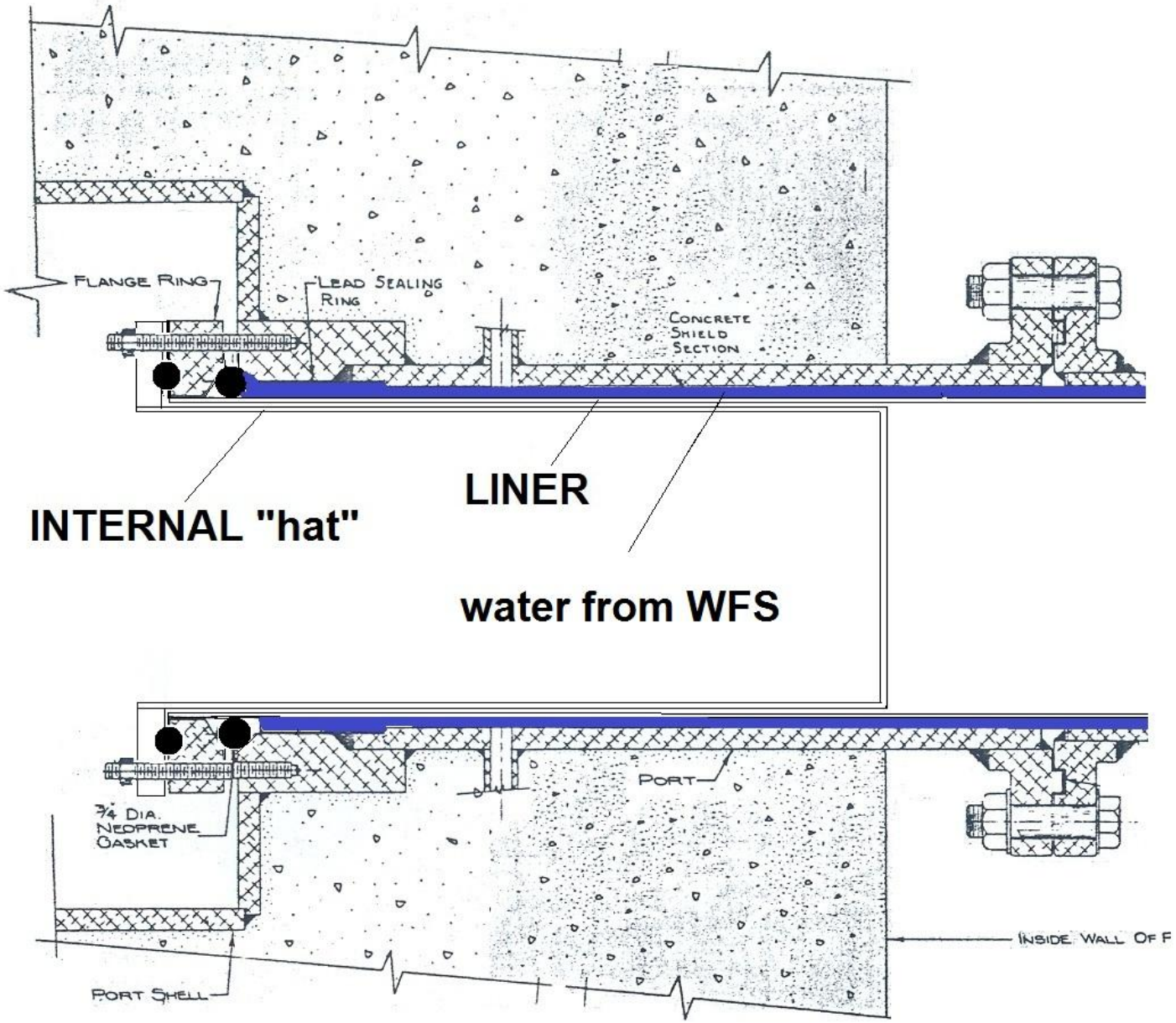


BEAM HOLE 3 with Internal HAT - BNCT





DETAIL : EXTERNAL "hat"

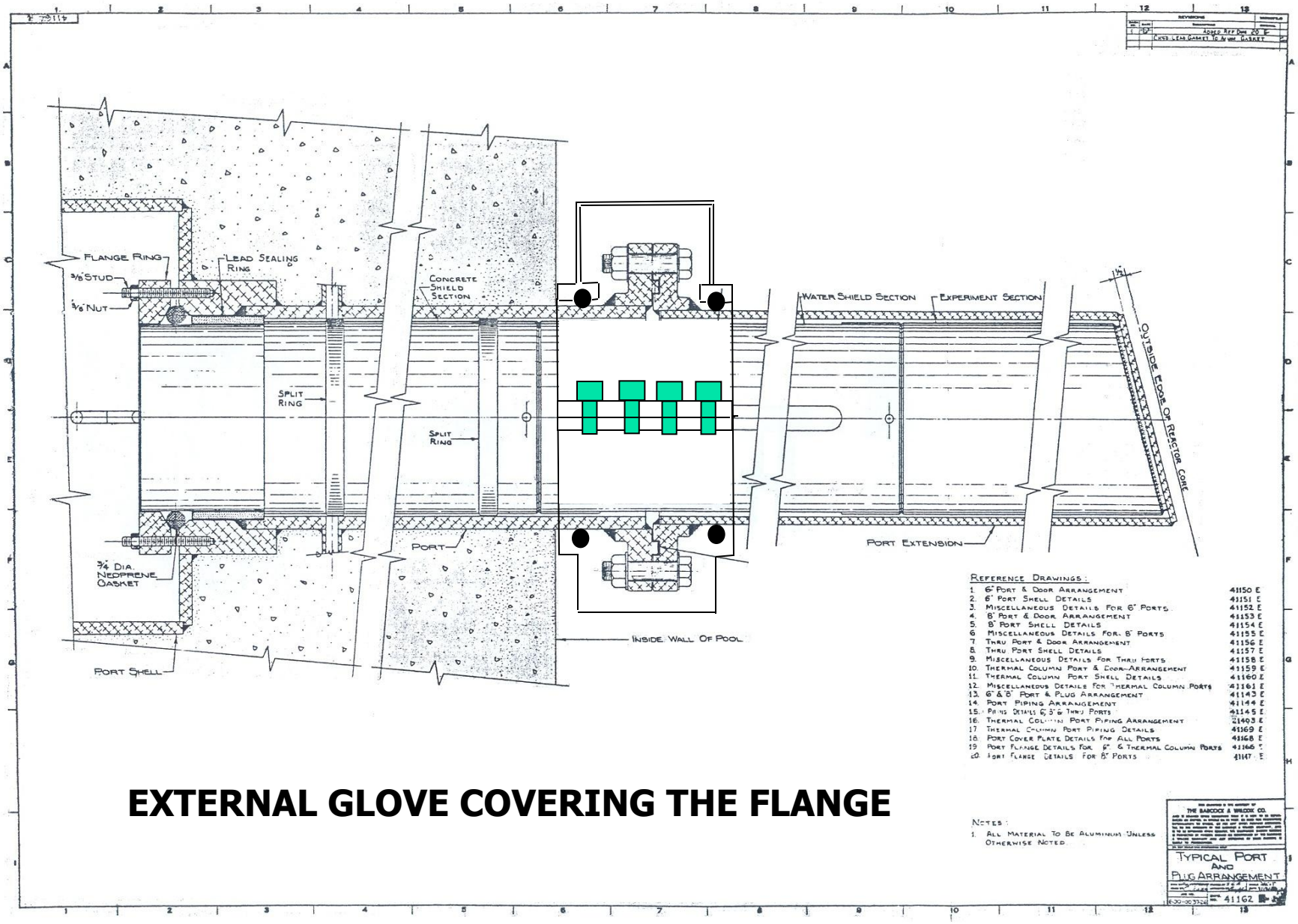


DETAIL : INTERNAL "hat"

BEAM HOLES – PROBLEMS AND SOLUTIONS

PROBLEM 2 : A small leakage of pool water through the flange of the tangential BH was detected.

SOLUTION 2 : The solution to avoid emptying the pool was the assembling of an external "Glove", with special rubber joint and bolts, covering the flange. All assembling operation was done using specifically developed tools for distance operations.

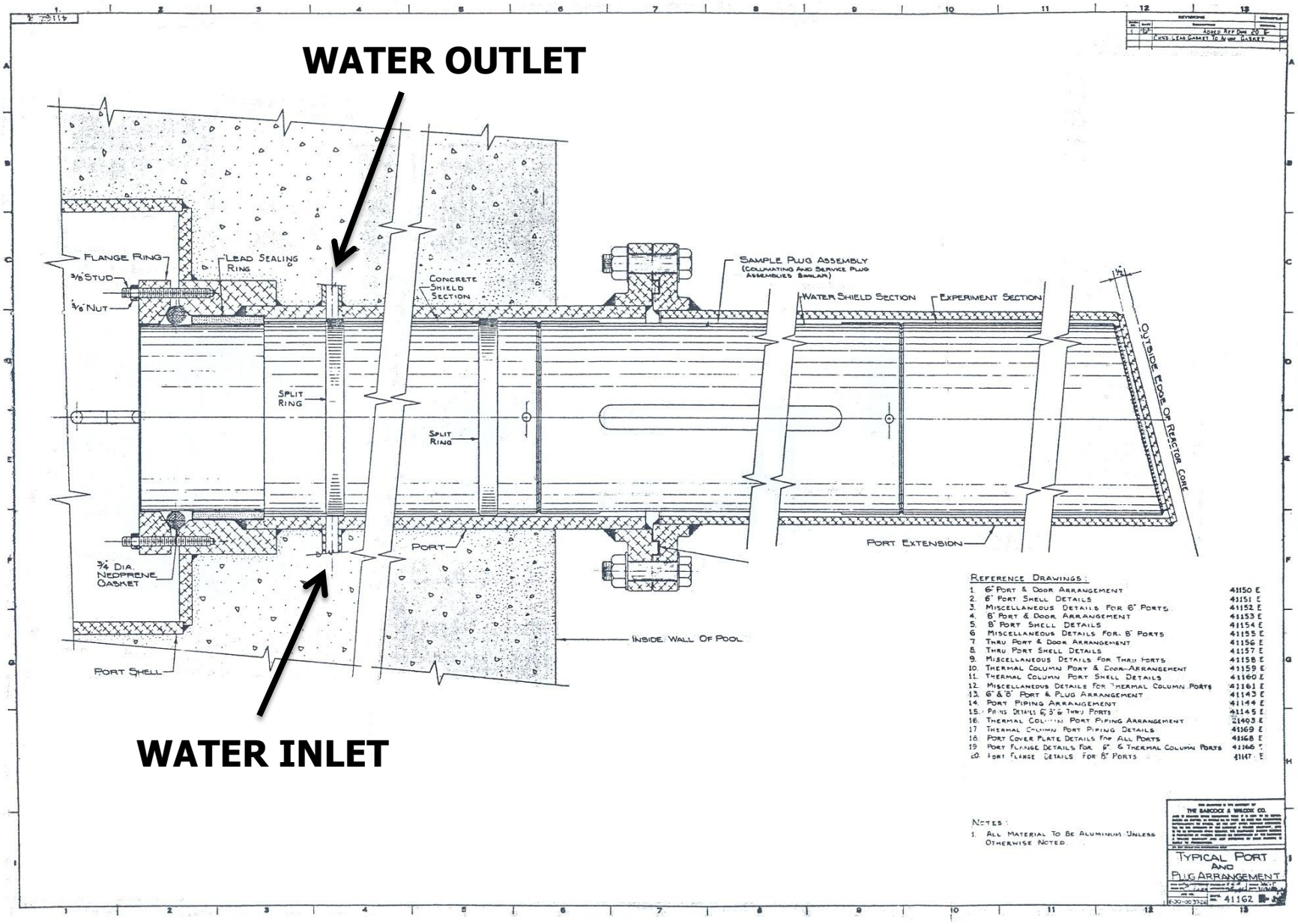


EXTERNAL GLOVE COVERING THE FLANGE

BEAM HOLES – PROBLEMS AND SOLUTIONS

PROBLEM 3 : Increase of the radioactive doses in the experimental hall next to BH 14 due to lack of water shield in the upper part of the BH was detected. Valves of the water filling system are 55 years old, and might be leaking.

SOLUTION 3 : The solution was to add a small elevated tank connected to the outlet line of the BH's. This tank works as a pressurizer to maintain the pressure of the system and keep it filled, and accommodates changes in water density due to temperature.


WATER OUTLET
WATER INLET
FLANGE RING
LEAD SEALING RING
3/8 STUD
3/8 NUT
CONCRETE SHIELD SECTION
SAMPLE PLUG ASSEMBLY (COLLIMATING AND SERVICE PLUG ASSEMBLIES SIMILAR)
WATER SHIELD SECTION
EXPERIMENT SECTION
OUTSIDE FACE OF REACTOR CORE
SPLIT RING
SPLIT RING
PORT
PORT EXTENSION
3/4 DIA. NEOPRENE GASKET
INSIDE WALL OF POOL
PORT SHELL
REFERENCE DRAWINGS:
1. 6" PORT & DOOR ARRANGEMENT 41150 E
2. 6" PORT SHELL DETAILS 41151 E
3. MISCELLANEOUS DETAILS FOR 6" PORTS 41152 E
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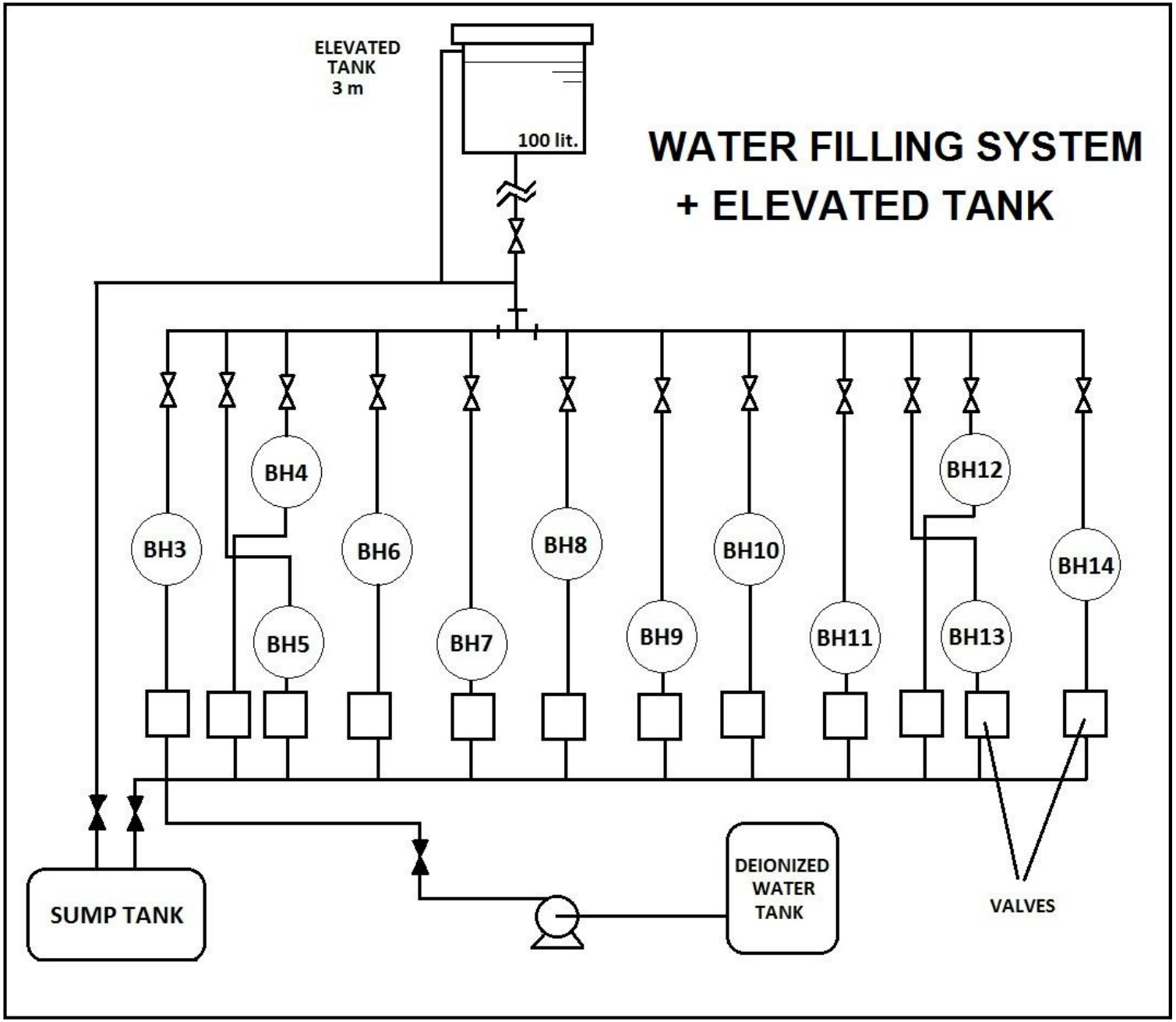
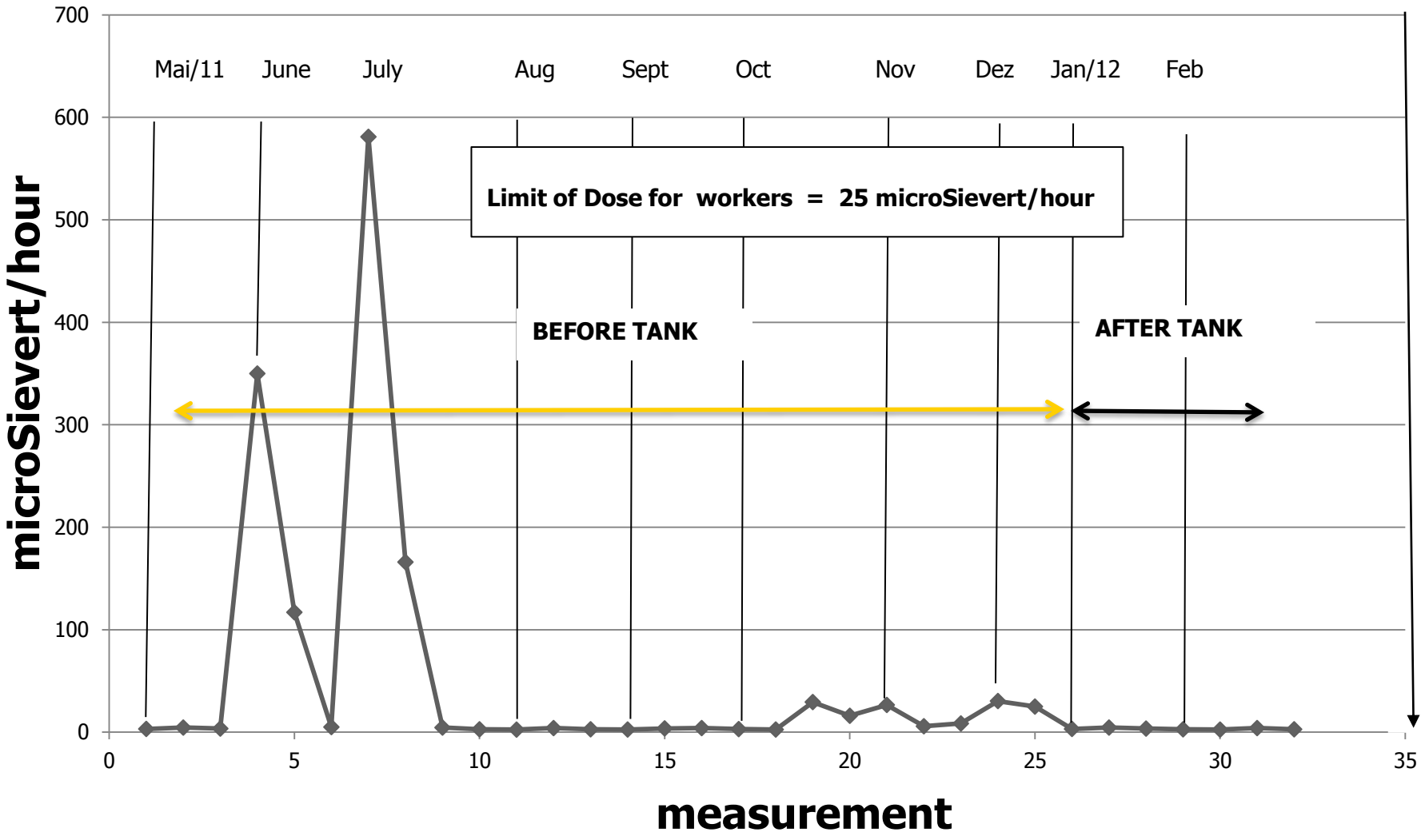
THE BABCOCK & WILCOX CO.
TYPICAL PORT AND PLUG ARRANGEMENT
41162


ELEVATED
TANK
3 m
100 lit.
WATER FILLING SYSTEM
+ ELEVATED TANK
BH3
BH4
BH5
BH6
BH7
BH8
BH9
BH10
BH11
BH12
BH13
BH14
SUMP TANK
DEIONIZED
WATER
TANK
VALVES


700
600
500
400
300
200
100
0
Mai/11
June
July
Aug
Sept
Oct
Nov
Dez
Jan/12
Feb
Limit of Dose for workers = 25 microSievert/hour
BEFORE TANK
AFTER TANK
microSievert/hour
0
5
10
15
20
25
30
35
measurement

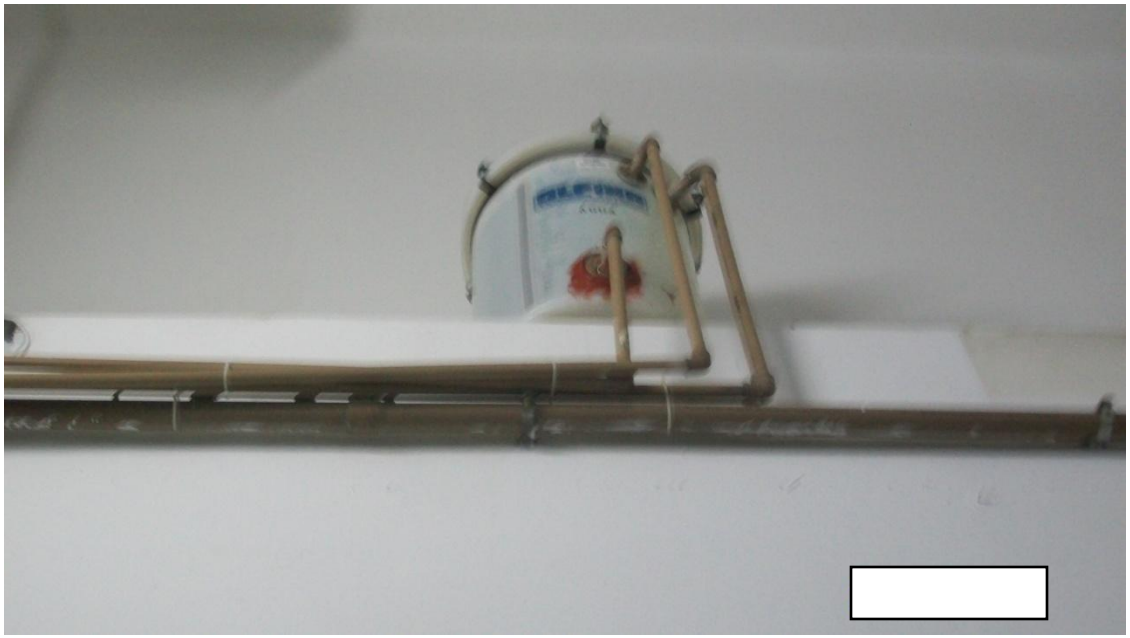
CONCLUSIONS AND RECOMMENDATIONS

1. BEAM HOLES MUST BE CAREFULLY AND INDIVIDUALLY FILLED FOLLOWING THE OPERATIONAL PROCEDURES TO AVOID ADDITIONAL AND UNNECESSARY DOSES TO WORKERS;

2. SOME IMPROVEMENTS AND CHANGES IN ORIGINAL DESIGN MUST BE MADE IN ORDER TO INCREASE THE SAFETY OF THE REACTOR;

3. IF THE RESEARCH REACTOR IS IN DESIGN PHASE, THE NEUTRON BEAMS (BH's) MUST BE CAREFULLY DESIGNED CONSIDERING ALL ACCIDENT POSSIBILITIES AND FILLING PROBLEMS;

4. PREVISIONS TO MAKE FUTURE OPERATIONS OF MAINTENANCE EASY, AND FOR ACCESSIBILITY TO OPERATORS WHEN ASSEMBLING, DISASSEMBLING AND CLEANING BEAM HOLES MUST BE INCLUDED IN DESIGN PHASE.



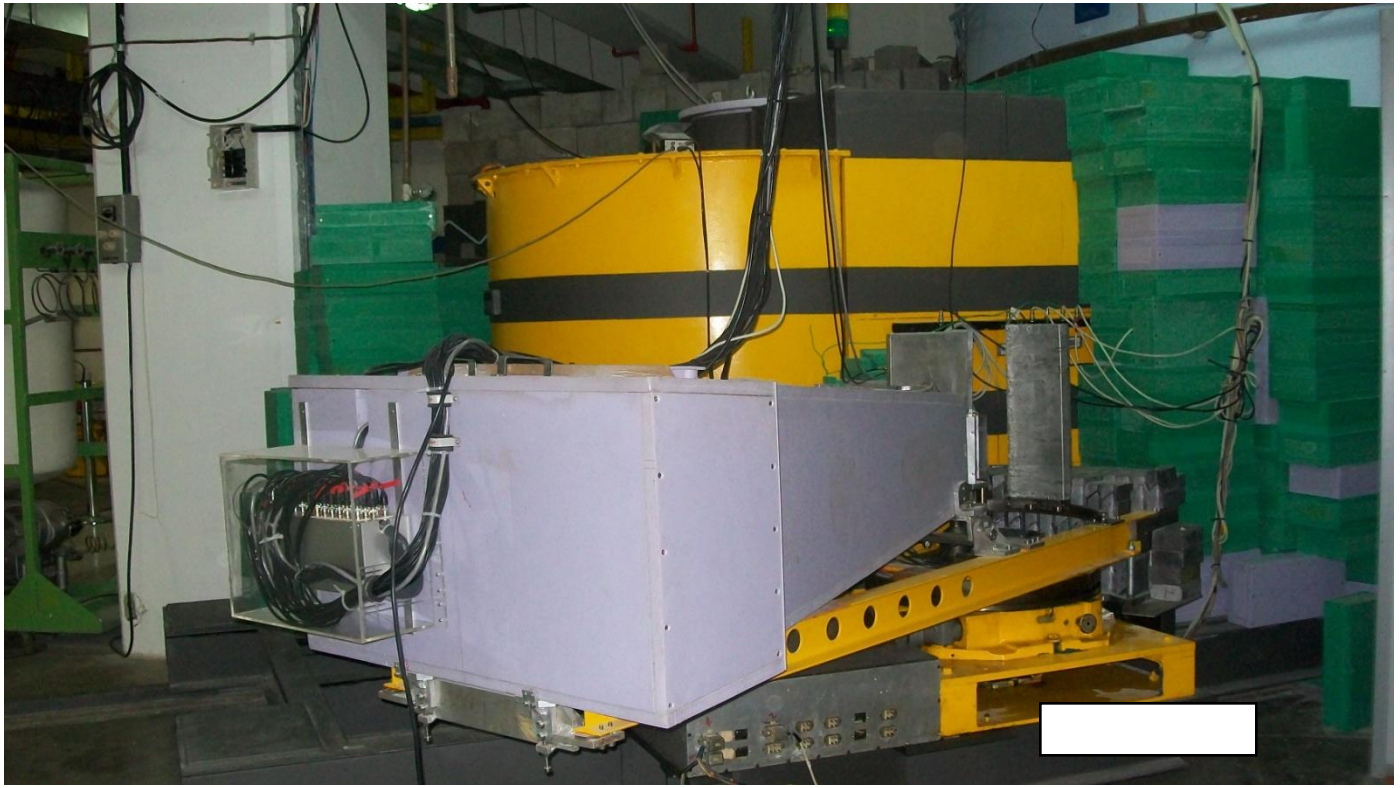
ELEVATED TANK

BNCT

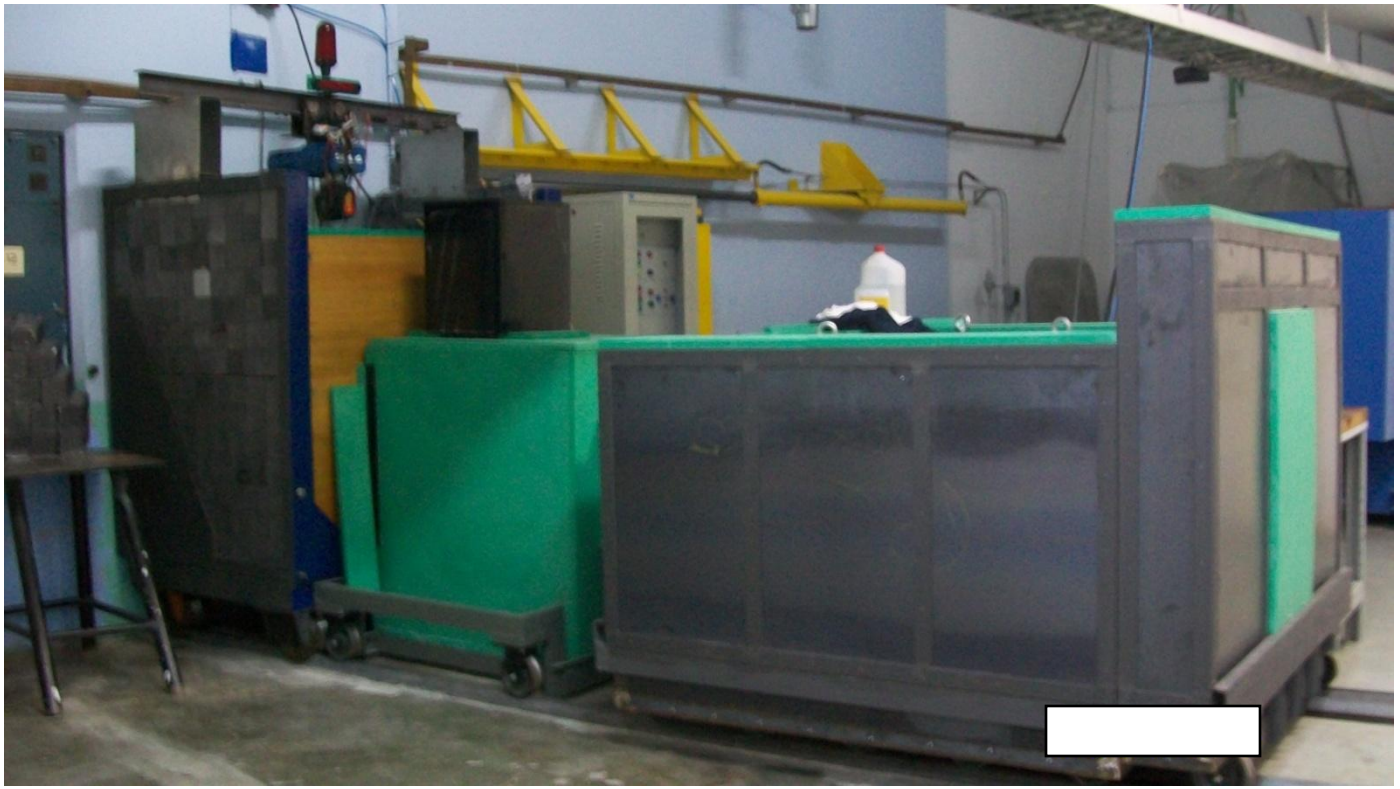
BNCT

NEUTRON DIFRACTION

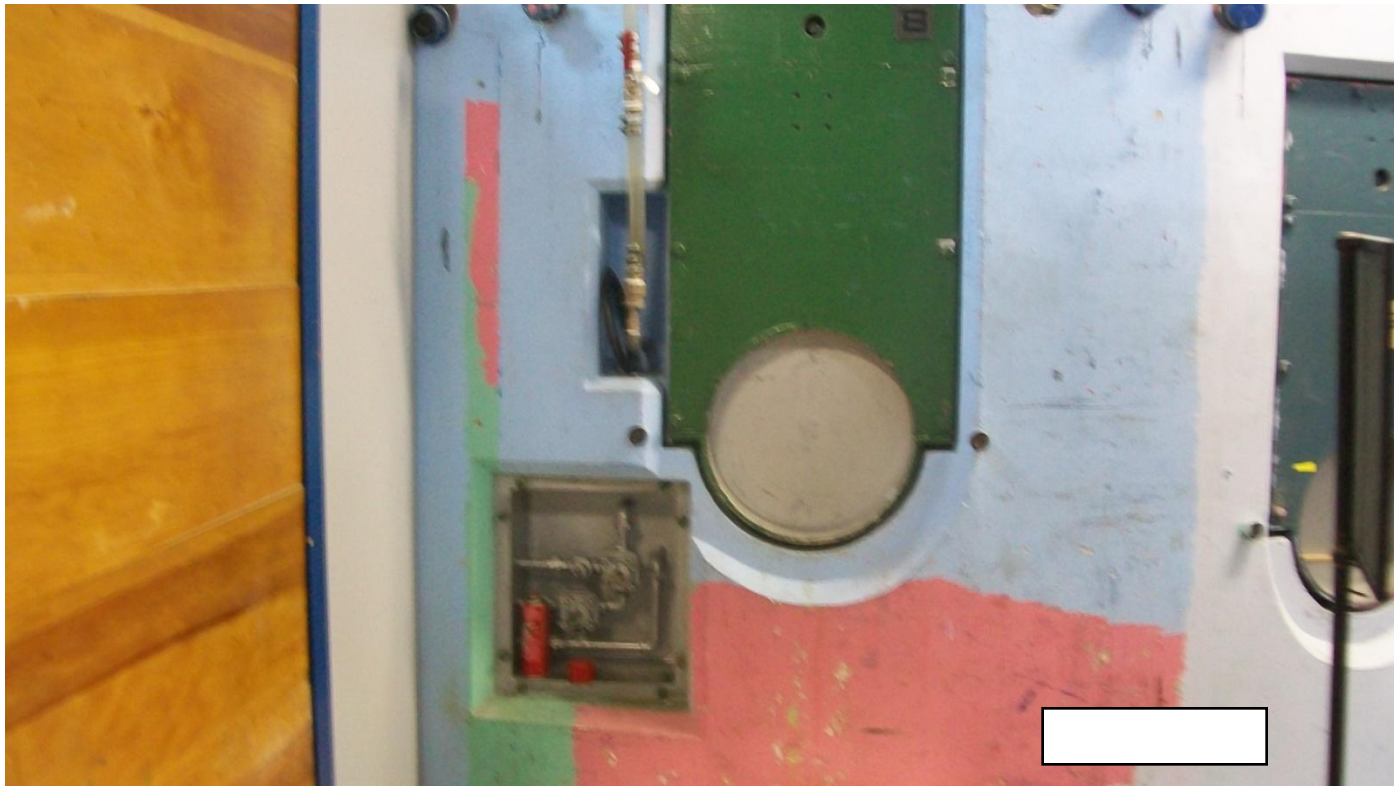
NEUTRON DIFRACTION



NEUTRONGRAPHIE

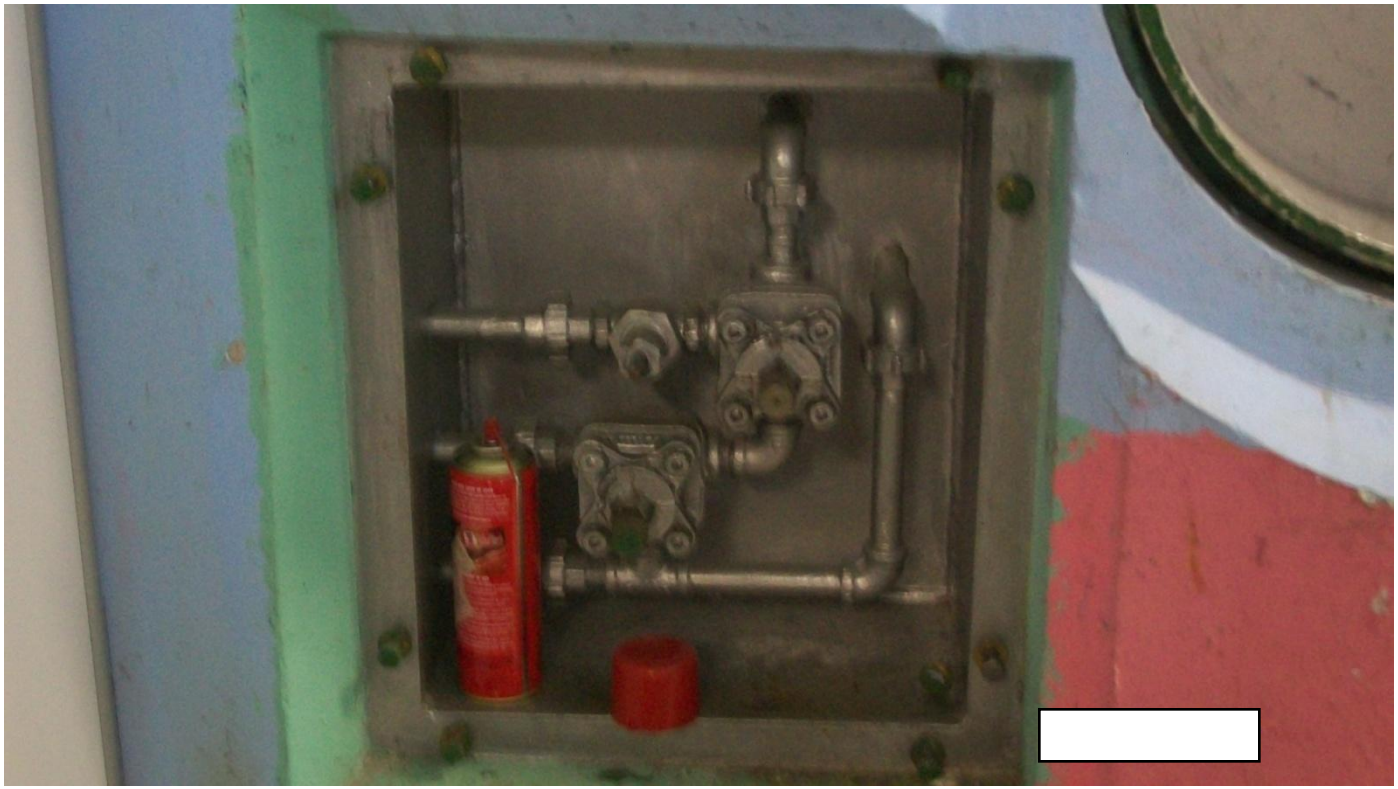


BH's AND VALVES

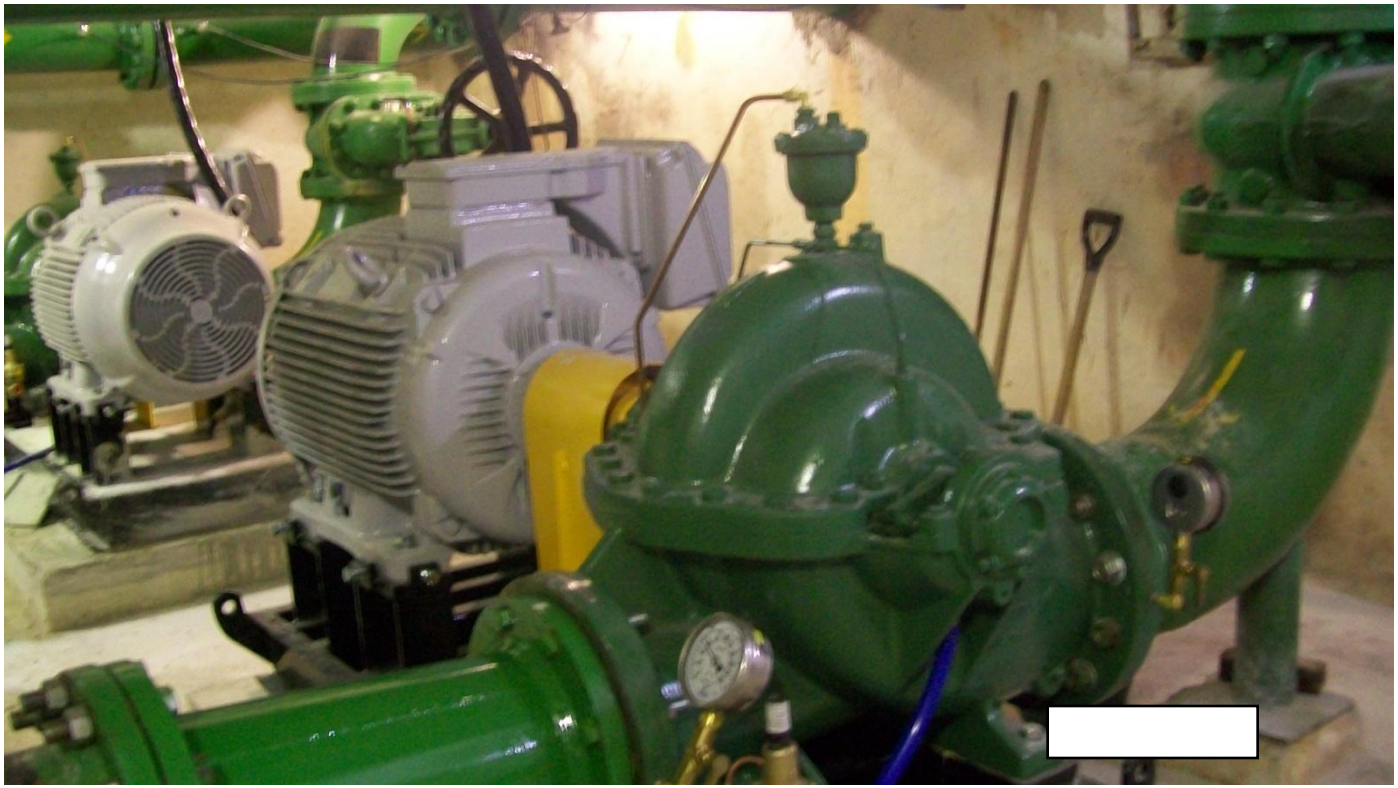


BH's AND VALVES

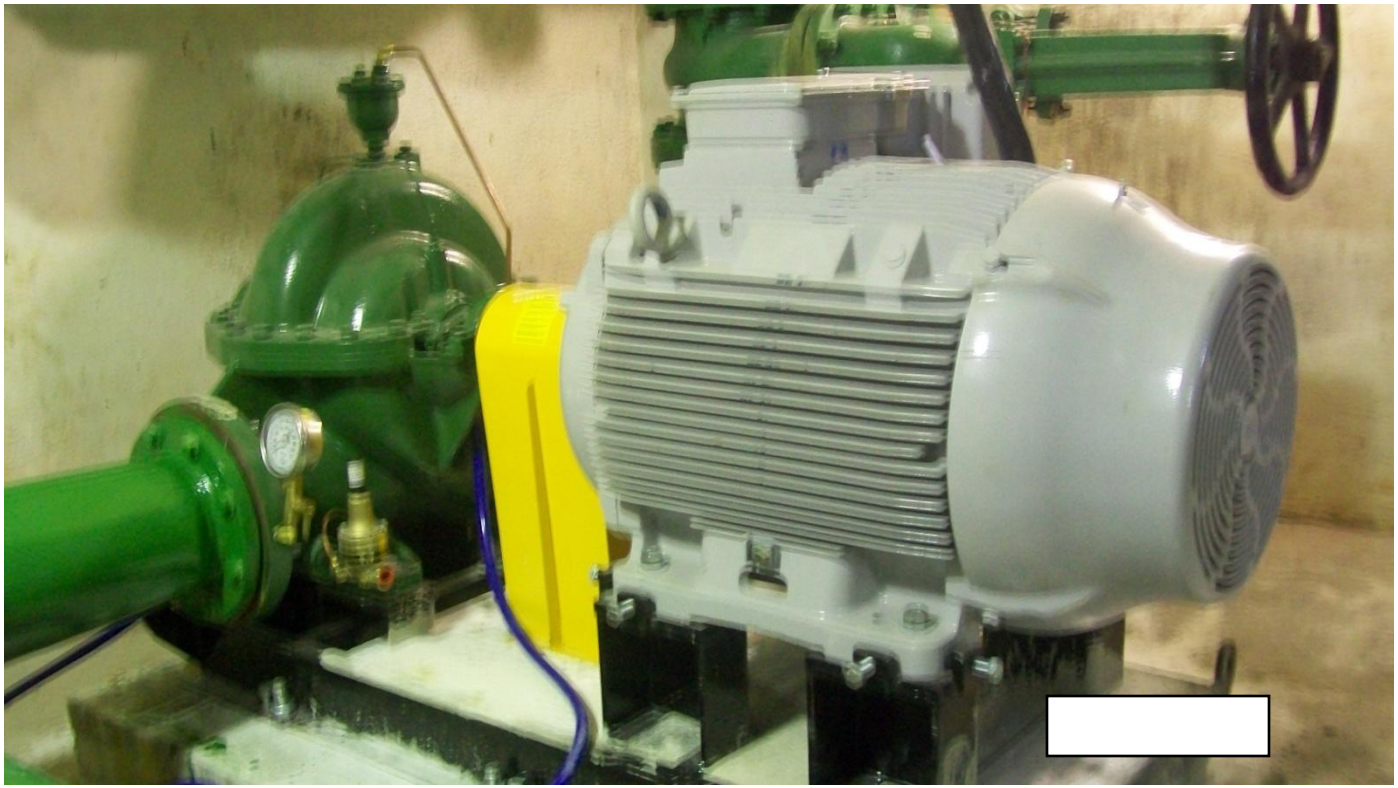
VALVES OF WF SYSTEM



NEW MOTOR-PUMP SET



NEW MOTOR-PUMP SET



FREQUENCY INVERTER OF THE MP SET

Acknowledgments

- IAEA by the financial support and hospitality
- Nuclear and Energy Research Institute (IPEN-CNEN/SP)
- Brazilian Nuclear Energy National Commission (CNEN)

Thank you !!!