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1. Terms and Definitions

NOTE:	Notes separate important information from the text and give additional information.
CAUTION:	"An instruction that draws attention to the risk of damage to the product, process or surroundings" (BS 4884-1: 1992).
WARNING:	"An instruction that draws attention to the risk of injury or death" (BS 4884-1: 1992).

2. References & Related Documents

Document Number	Document Title	Notes

3. Document Purpose and Overview

These Work Instructions give detailed procedures for modifications to be undertaken during changing system cooling on the 5-089-000260 Liquid Cooled Reactor.

NOTE: The procedures detailed in this Application Note should not be attempted unless they are fully understood and adequate training has been received. These procedures should be followed without any deviation from the sequence order. Before any work is commenced, the 'Method Statement & Risk Analysis' should have been read and any local site induction courses attended.

SAFETY INSTRUCTIONS

Care has been taken with the design of this product to ensure that it is safe. However, in common with all products of this type, misuse can result in injury or death. Therefore, it is very important that the instructions in this manual and on the product are observed during transportation, commissioning, operation, maintenance and disposal.

This technical manual must be regarded as part of the product. It should be stored with the product and must be passed on to any subsequent owner or user.

Local safety laws and regulations must always be observed.

Persons working on the product must be suitably skilled and should have been trained in that work for these products.

The product is a component designed for incorporation in installations, apparatus and machines. The product must not be used as a single item safety system. In applications where maloperation of the product could cause danger, additional means must be used to prevent danger to persons. Use of this instruction is at your own risk and Avid Controls assumes no responsibility for damage or injury as this is intended for information purposes only. Please ensure only suitably skilled personnel perform any activity. Product approvals and certifications will be invalidated if the product is transported, used or stored outside its ratings or if the instructions in this manual are not observed.

WARNING

- Ensure safe working at ALL times.
- Ensure converter cubicle is disconnected/isolated from ALL the mains/auxiliary supplies.
- Ensure Lockout/tagout and proving dead is undertaken as detailed in the appropriate Technical Manual.
- Ensure appropriate PPE is used at ALL times.
- Ensure that system cooling is empty (without liquid) and it is NOT under pressure.

4. Recommended PPE

The following is the minimum recommended PPE for this work:

- Safety shoes
- Eye protection
- Gloves
- Shirt with long sleeves

5. Tools Required

The following tools are required to successfully complete the work described in this document:

<u>Tool</u>	<u>Tool Use</u>
Cutter	Cut the Cable Ties
Cutter for tubes (optional)	Cut the Cooling Tubes
Torx TX30	Unscrew the Distribution Blocks
Wrench 8mm and 13mm	Unscrew the Hose Clamps and Support
6mm Allen (Key) Wrench	For Hose Support Clamps
Special Key for Hose Clamp	Assembler Hose Clamp
Cable Tie Applicator	For Cable Ties
Torque Wrench 12Nm	For Hose Clamp Supports
Gauge A-900-710016R00 (Pic. 6.1.)	For Hose Clamp Position



Pic.1 Cutter



Pic.2 Cutter for tubes



Pic.3 Torque wrench



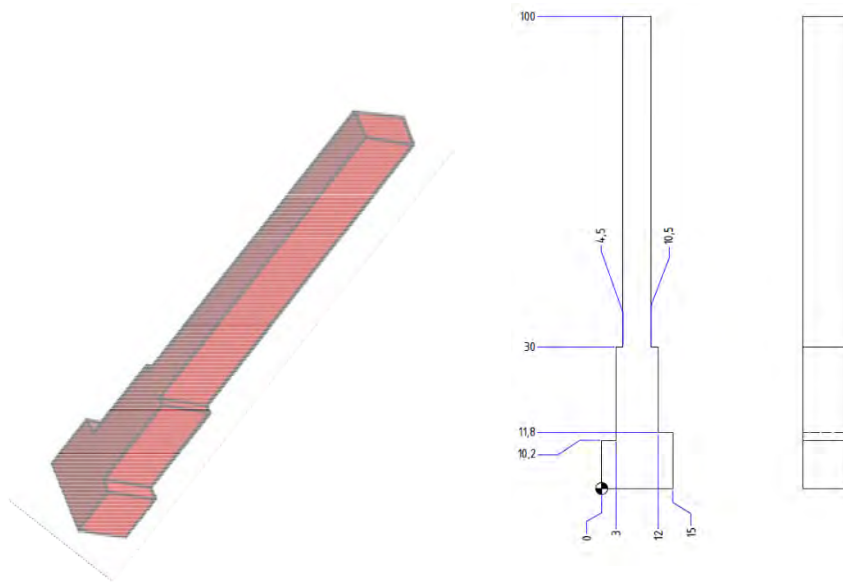
Pic.4 Cable Tie applicator



Pic.5 Special key for hose clamp



Pic. 6 Wrenches



Pic. 6.1 Clip Gauge A-900-710016R00

6. Bill of Materials

The following itemizes the contents of the changing tubes kit to be supplied for this work:

<u>Item</u>	<u>Description</u>	<u>Qty</u>	<u>Measurement</u>
	Distribution block assemblies A1&A2	1	Piece
1-370-000367	Kit of Tubes	1	Piece
1-900-001032	Hose Clamp	24	Piece
1-900-001051	Hose Support	5	Piece
1-431-001172	Screw M8x45 DIN912 A2	3	Piece
1-431-100254	Screw M8x35 DIN912 A2	2	Piece
1-431-100950	Washer M8 DIN125 A4	5	Piece
1-431-000419	Nut M8 DIN934 BN628	5	Piece
1-342-000287	Support SG200 10x18x90	2	Piece
1-425-000610	Cable Tie	10	Piece
1-431-006715	Screw TORX M6x16	4	Piece



Pic. 7



Pic. 8



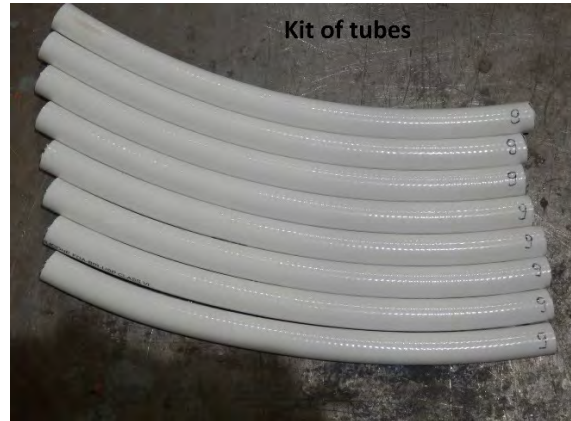
Pic. 9



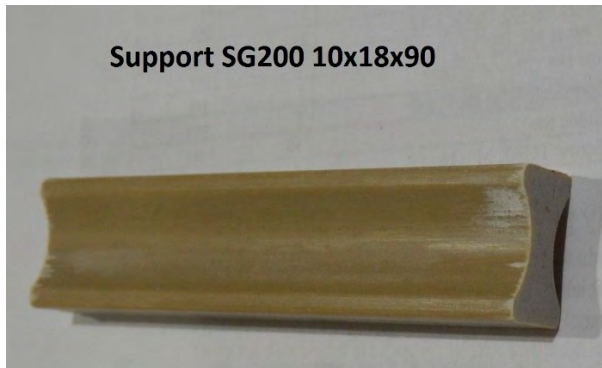
Pic. 10



Pic. 11



Pic. 12



Pic. 13



Pic. 14

7. Disassembly procedure of blue tubes.

To begin the procedure, do the following:

- Ensure converter cubicle is disconnected/isolated from ALL the mains/auxiliary supplies.
- Drain converter and ensure that system cooling is empty (without liquid) and it is NOT under pressure.
- Open converter cubicle and remove covers (as in the picture below).



Pic. 15

7.1 Drain reactor coolant

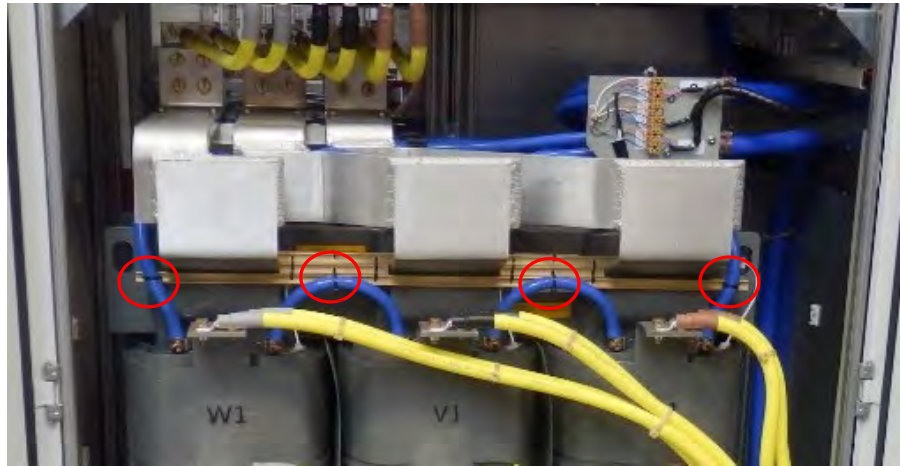
If coolant is present in existing tubes, it is essential to drain this carefully ensuring no coolant ingress to the windings. It is recommended to use either compressed air or a pump to force the coolant from the reactor. Ideally use the inlet and outlet connections on the Distribution Block to blow coolant through.

7.2 Cut the cable ties

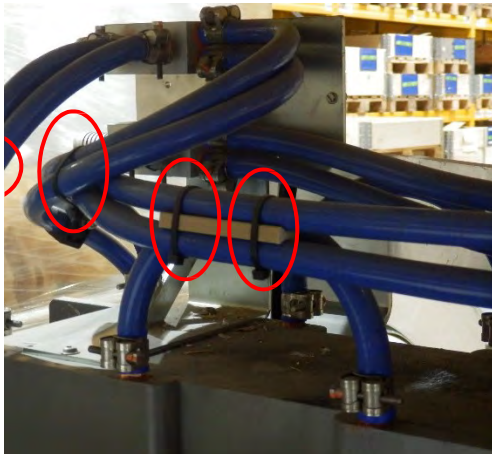
Tools: Cutter

Materials: -

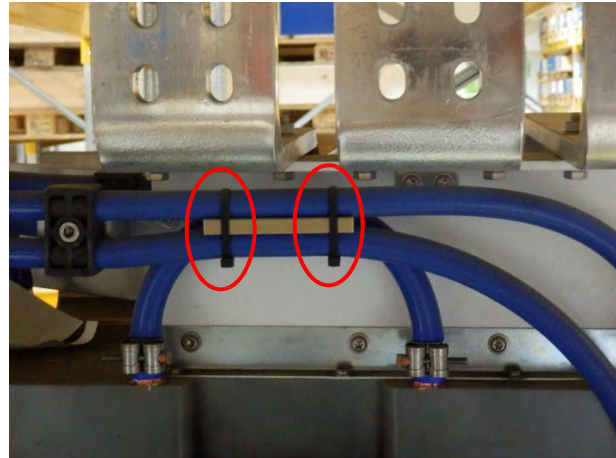
Action: Cut the cable ties which are used as support for tubes



Pic. 16



Pic. 17



Pic. 18

7.3 Remove support of hoses.

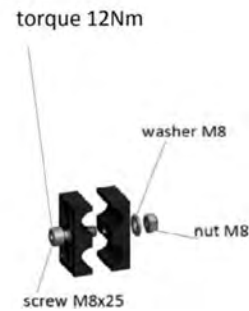
Tools: Allen key 6mm, wrench 13mm

Materials: -

Action: Unscrew and remove support.



Pic. 19

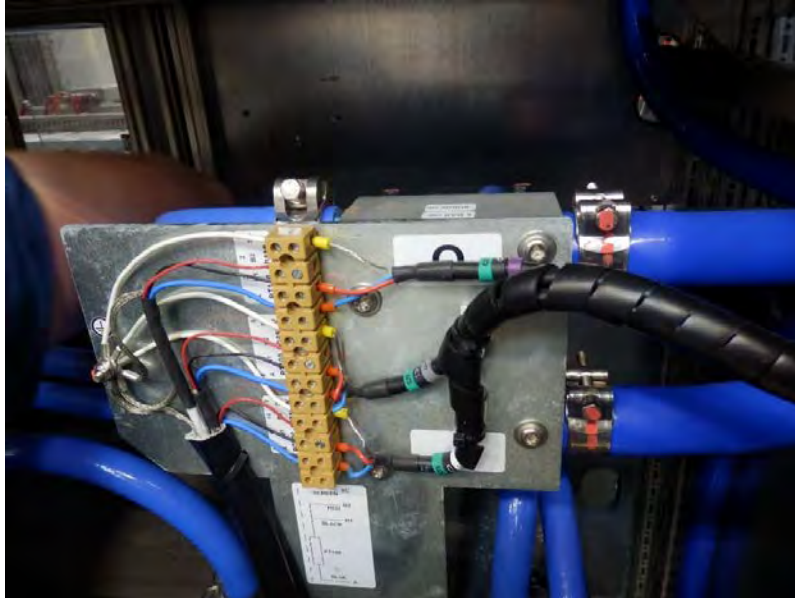


7.4 Unscrew hose clamp and cut the hose.

Tools: Cutter for tubes, wrench 8mm

Materials: -

Action: Unscrew hose clamp. Displace clamp along hose. Cut the hose at the main nipple.



Pic 20

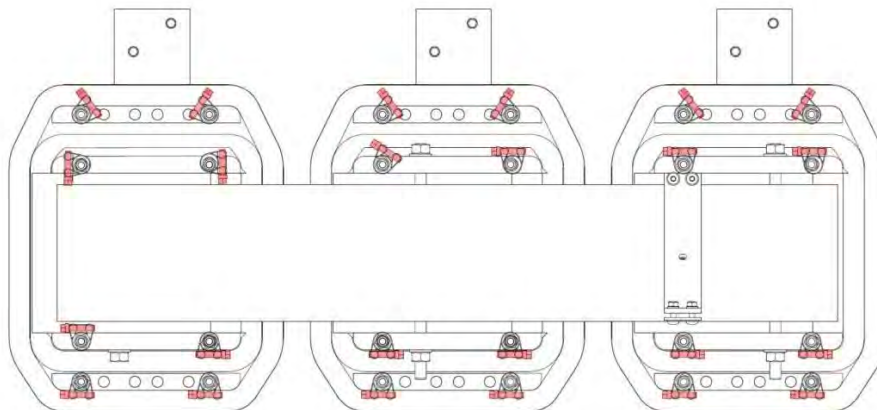
7.5 Disassembly of hoses and clamps.

Tools: wrench 8mm

Materials: -

Action: Unscrew all hoses clamp in cooling block on coils.

Clamp Positions Viewed from the top of the Reactor



Pic. 21



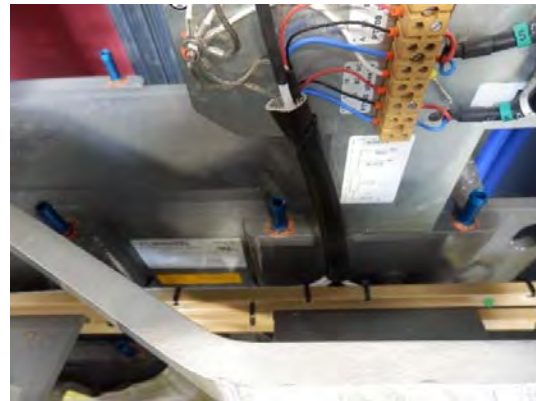
Pic. 22



Pic. 23



Pic. 24



Pic. 25

7.6 Remove old distribution blocks

Tools: Torx TX30

Materials: -

Action: Unscrew and disassembly the distribution blocks.



Pic. 26

8. Assembly procedure of tubes.

Once all blue tubes are removed and old distribution blocks should be fitted as detailed below:

8.1 Fitment of hoses and clamp

Tools: Special key for hose clamp, gauge A-900-710016R00

Materials: Kit of tubes (1-370-000367), hose clamps

Action: Insert the tube into the clamp before connecting tube to the hose nipple. Use the special key to place the hose clamp as shown below.

CAUTION

- Ensure that the clip is in the right position.
- Ensure that the clips 'ears' do not touch other parts.

NOTE

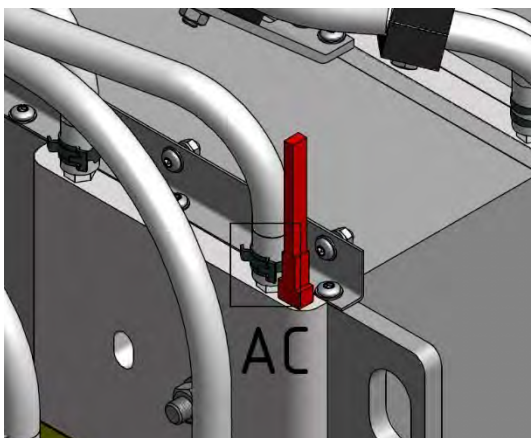
- Use inspection camera in an area of low visibility or access.
- Position the hose clamp set by the gauge A-900-710016R00 (Pic 30).



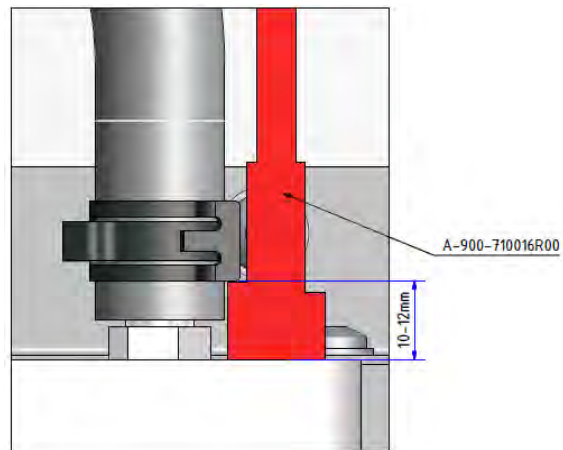
Pic. 27



Pic. 28



Pic. 29



Pic. 30

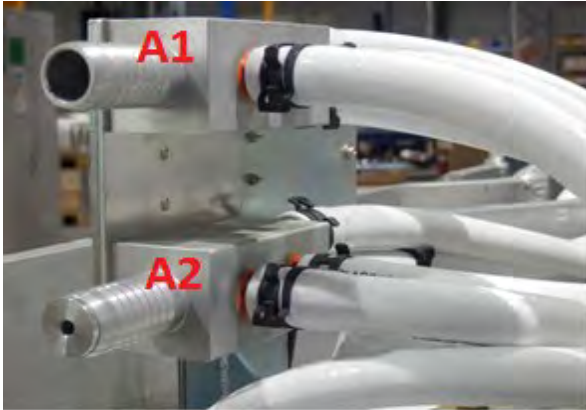
CAUTION. Once a hose is fitted, do not attempt to remove and refit for any reason. If a refit is required for any reason, a new hose must be used.

8.2 Mounting distribution block assemblies A1 & A2

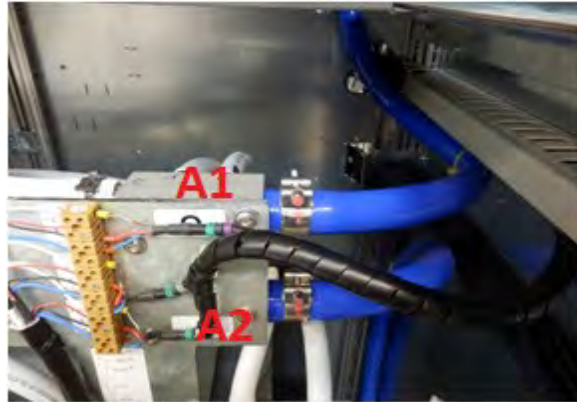
Tools: Torx TX30, Special key for hose clamp

Materials: Screw TORX M6x16, hose clamps

Action: Using the retained Torx headed screws (held in a safe place on removal of original blocks) fit the preassembled Distribution Blocks A1 and A2 from the Kit.



Pic. 31



Pic. 32

Note: Distribution block A2 (Inlet) has a flow restrictor fitted as shown



Pic. 33

Connect the free ends of the hoses to the locations shown in Figure 1 and Figure 2, using the procedure detailed in section 6.1 of this document. These are the destinations for the hoses connected to the Distribution Blocks. Labels are fitted to these hoses at their free ends for guidance. Refer to Pic. 11 and Pic. 12 to locate the destinations on the reactor.

A1 Hose destinations are B1, B7 and F6, F12 (See Figure 1), without reducer

A2 Hose destinations are F1, F7 and B6, B12 (See Figure 1), with reducer.

CAUTION.

The connection of these hoses is critical to the cooling of the reactor and could affect the performance if not done correctly. Failure to comply with the above could result in the reactor being unserviceable

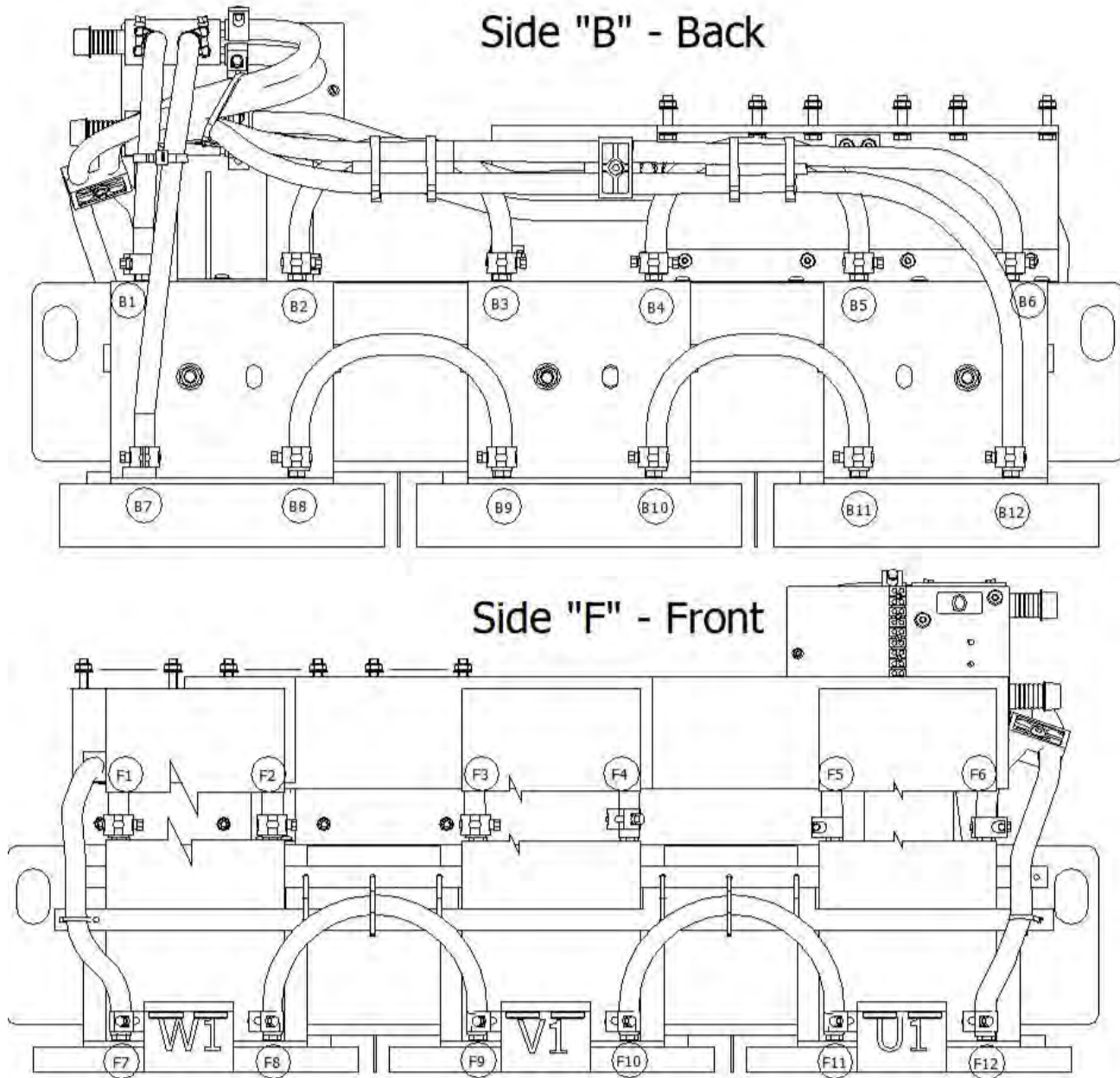


Figure 1. Hose connection destinations and identification. In this instruction, each connection point/destination is given a number and a letter to indicate position on Front or Back view of the reactor. (Note: Larger printable version located in Appendix.)

Once the Distribution block hoses are connected to the correct destinations, fit the remaining hoses as per Figure 2.

CAUTION. Once a hose is fitted, do not attempt to remove and refit for any reason. If a refit is required for any reason, a new hose must be used.

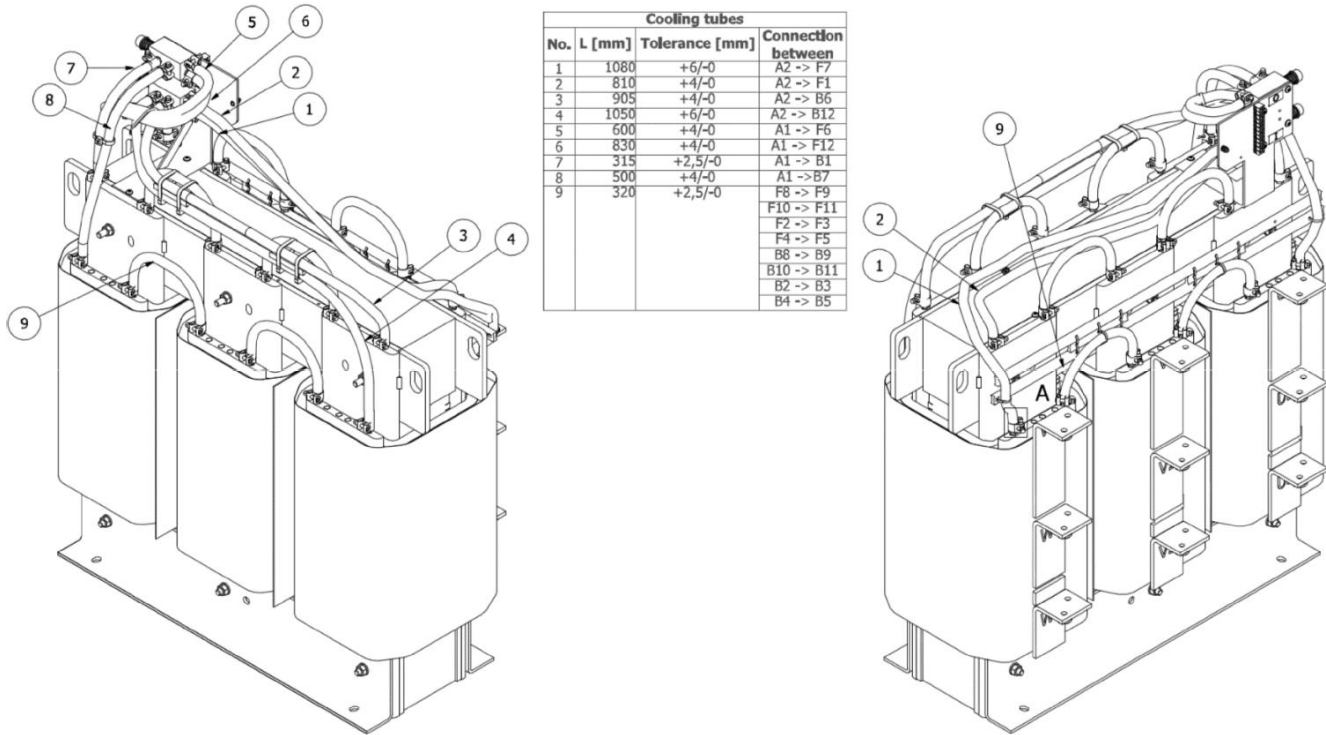


Figure 2. Reactor hose connection plan (Note: Larger printable version located in Appendix.)

8.3 Support of hoses.

Tools:

Materials: -

Action:

The hose runs on the top of the reactor are to be supported using a system of hose support clamps and cable tie spacers. There are 5 support clamps (item 1-900-001051) supplied with the kit for mounting on the hoses themselves as shown in Figure 3.

These clamps are to be opened to enable the hoses to be clamped firmly.

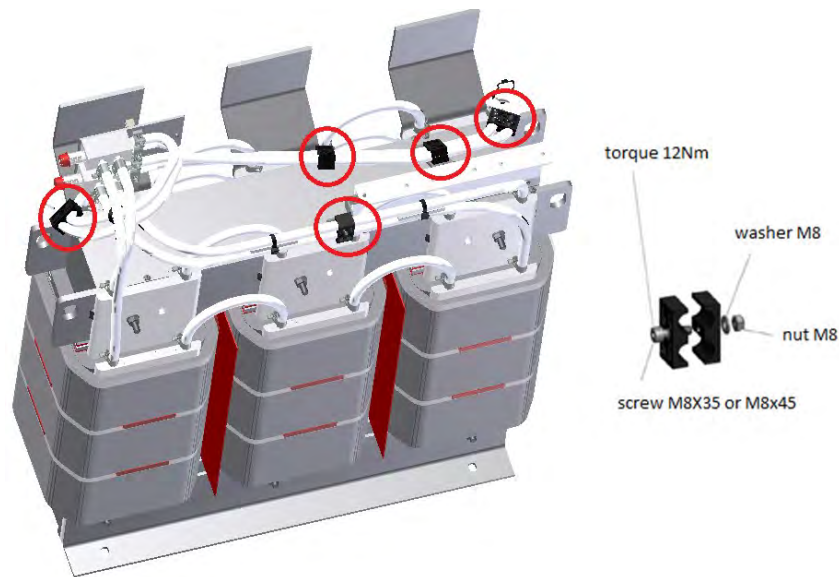


Figure 3. Hose support clamp location, operation and tightening torque

Once the hoses are positioned in the support clamps, the clamps should be tightened carefully to 12Nm using a 6mm Allen Key and an M8 socket fitted torque wrench, ensuring that the hoses are snug and not pinched or trapped in the clamp.

Fix the hoses shown in to the 3 support clamps fitted to the Insulating Support Bracket as shown in Figure 5. and fit the remaining 2 support clamps directly to the hoses in the positions shown. Ensure the 3 support clamps fitted to the bracket are oriented at right angles to the mounting location once tightened as shown below.

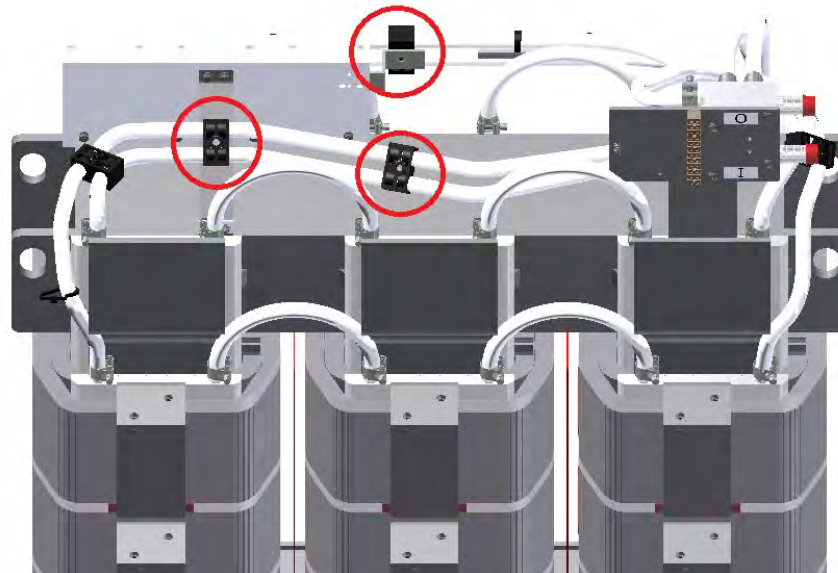


Figure 4. Hose support clamp location, operation and tightening torque

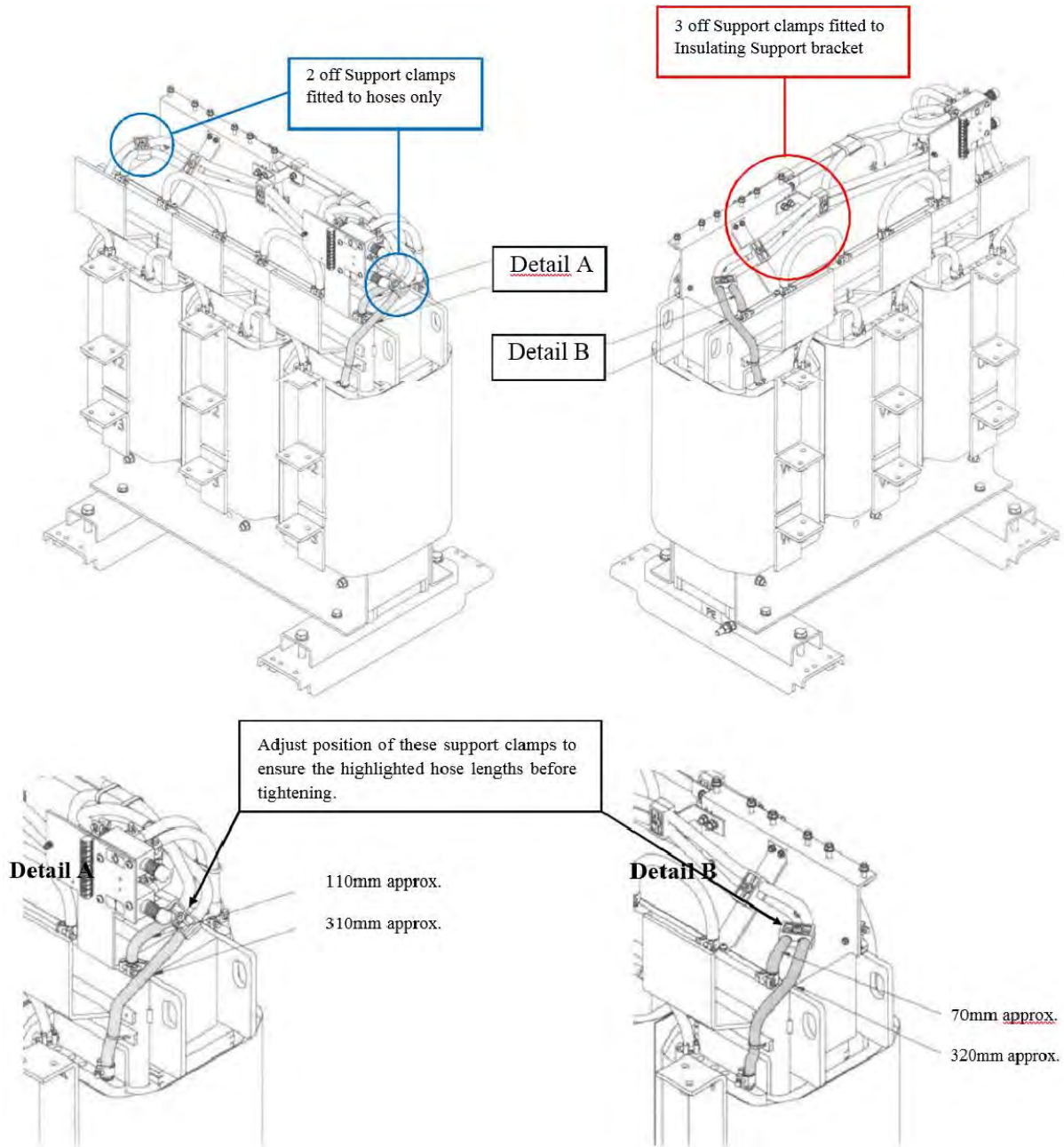


Figure 5. Hose support points

Two cable tie-based supports should then be added to the hoses that run along the back of the reactor and further cable ties are used to secure the hose runs on the front of the reactor. These are shown and positioned as in Figure 6.

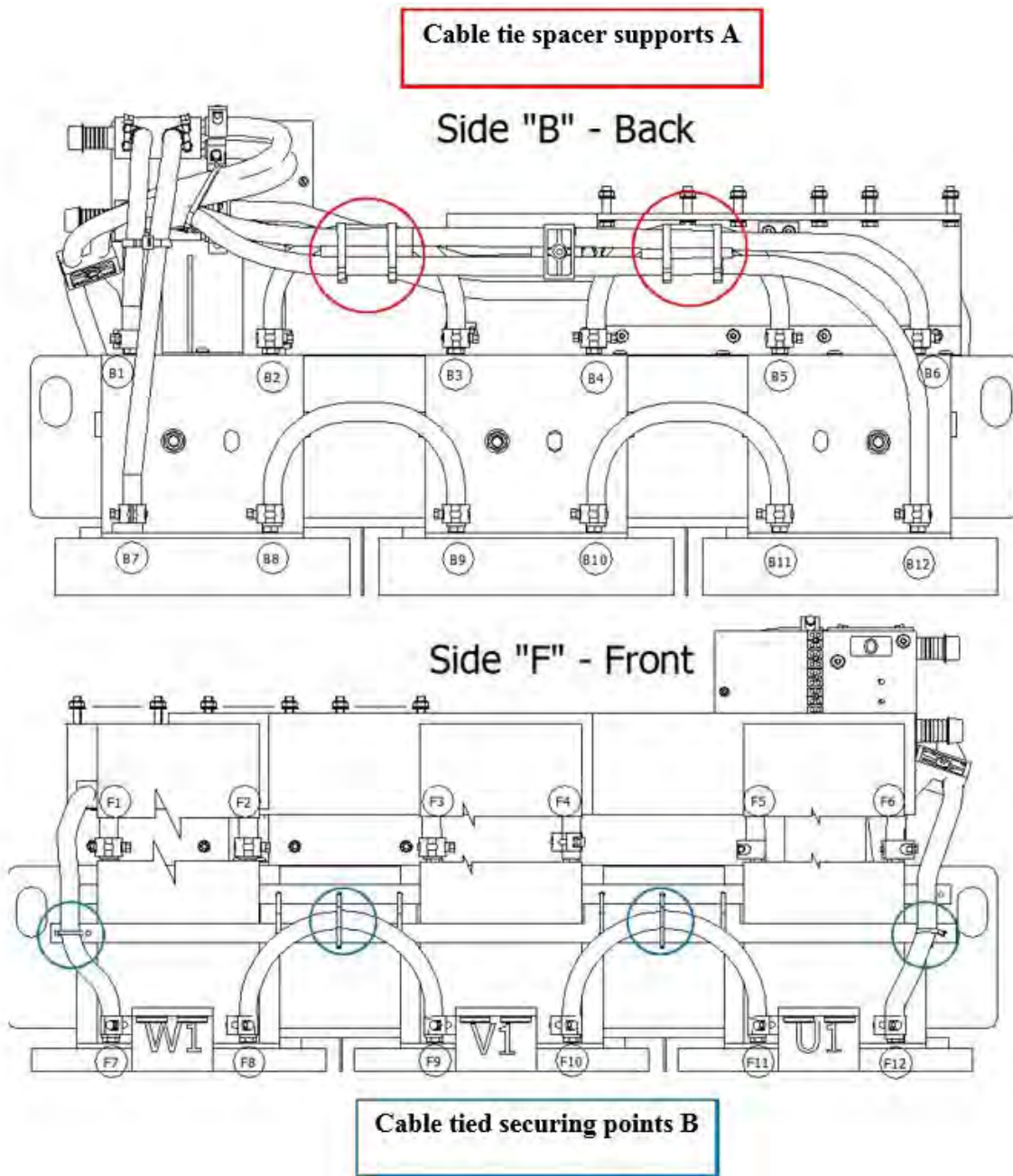


Figure 6. Cable tie-based hose supports

Cable tie spacer supports A



Pic. 34



Pic. 35

To construct the cable tie spacer supports, one of the 10x18x90mm "dog bone" section SG200 supports supplied with the kit is placed between the hoses that run from Distribution block A2 and destinations B6 and B12 (hoses 3 and 4 in Figure 2. Reactor hose connection plan). Two cable ties are then used as shown to tie the hoses 3 and 4 and the support piece to the hose loop connecting destinations B2 and B3. Repeat the above with the remaining "dog bone" section SG200 support and secure hoses 3 and 4 further along to the hose loop connecting destinations B4 and B5. Secure hoses 7 & 8 emerging from Distribution block A1 to each other with a cable tie as shown below. Bind hoses 5 & 6 emerging from Distribution block A1 to hoses 3 & 4 emerging from Distribution block A2 with a cable tie as shown below.

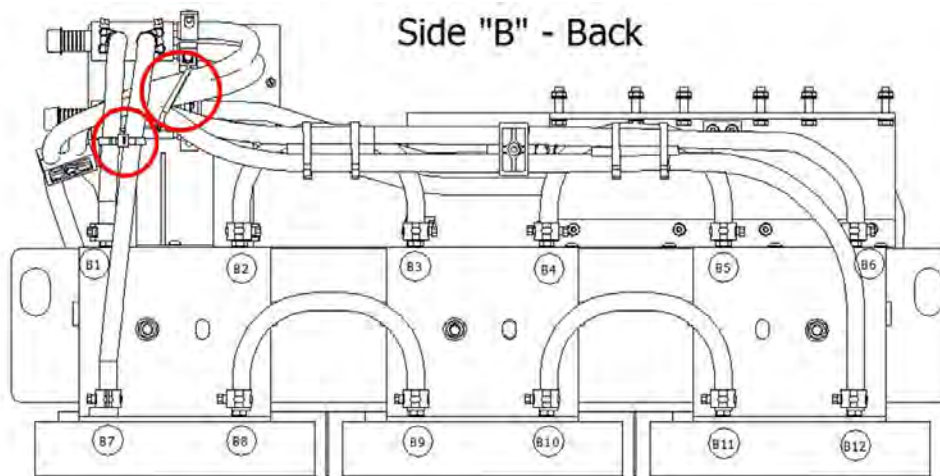
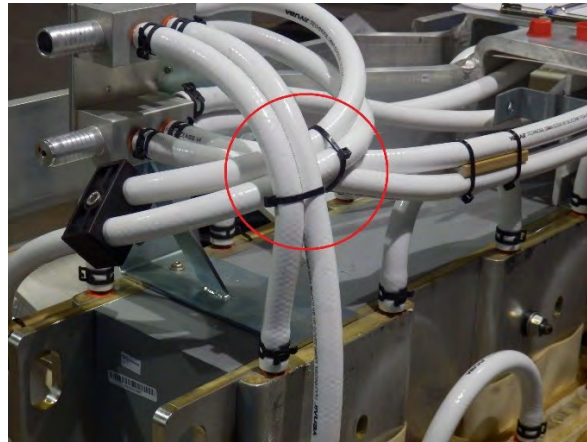


Figure 7. Cable tie-based hose supports



Pic. 36

When securely in place the cable tie ends should be carefully cut flush.



Pic. 37

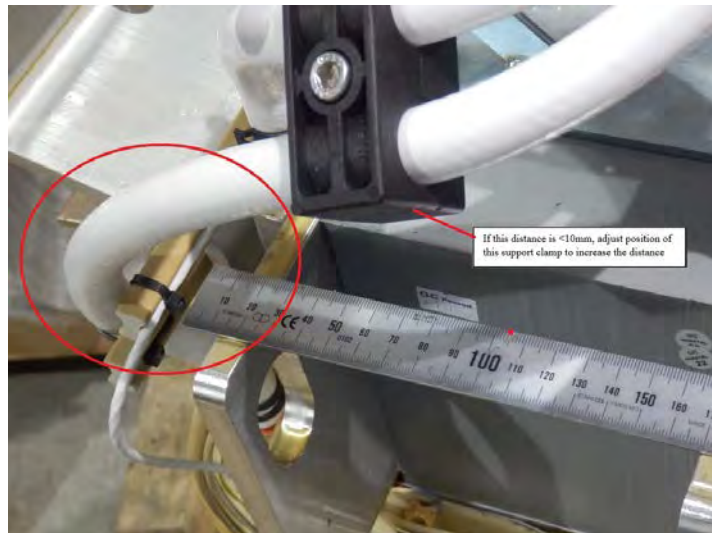
Cable tied securing points B

Attach hose loops between F8 and F9, F10 and F11 and hoses to F7 and F12 on the front of the reactor to the insulating support rails as shown in Figure 15 using the remaining cable ties. When securely in place the cable tie ends should be carefully cut flush.



Pic. 38

Once completed a check should be made that all hoses are undamaged and firmly supported, and that no excessive movement of the hoses is possible. A check should also be made to ensure that no hoses are in contact with any metal work of the reactor and that a minimum of 10mm clearance is ensured in any location where hoses lay close to the reactor body work. Pay particular attention to where the hoses that connect to F6 and F12 pass close to the reactor lifting plate as shown below. There must be a minimum of 10mm clearance in this location and if less, this distance should be adjusted by repositioning of the support clamp attached to these hoses.



Pic. 39

9. Final tests

9.1 Pressure test

Once this procedure has been completed and the reactor is fitted with the new silicon hose system, a pressure test must be performed to ensure that all connections and hoses are sound and that no leakage is present. The pressure test will require the use of Hand Pressure Test Pump (see Figure 8.), two shut-off valves and a calibrated pressure gauge (suitably graduated for an accurate indication of 6.0 Bar pressure), all with compatible connectors.

WARNING

- This test will result in a pressurized system.
- Ensure safe working at ALL times.
- Ensure appropriate PPE is used at ALL times.

CAUTION.

During any pressure testing, care should be taken to ensure that no coolant or other liquid is allowed to enter the reactor windings or associated insulation system. Failure to comply with the above could result in the reactor being unserviceable

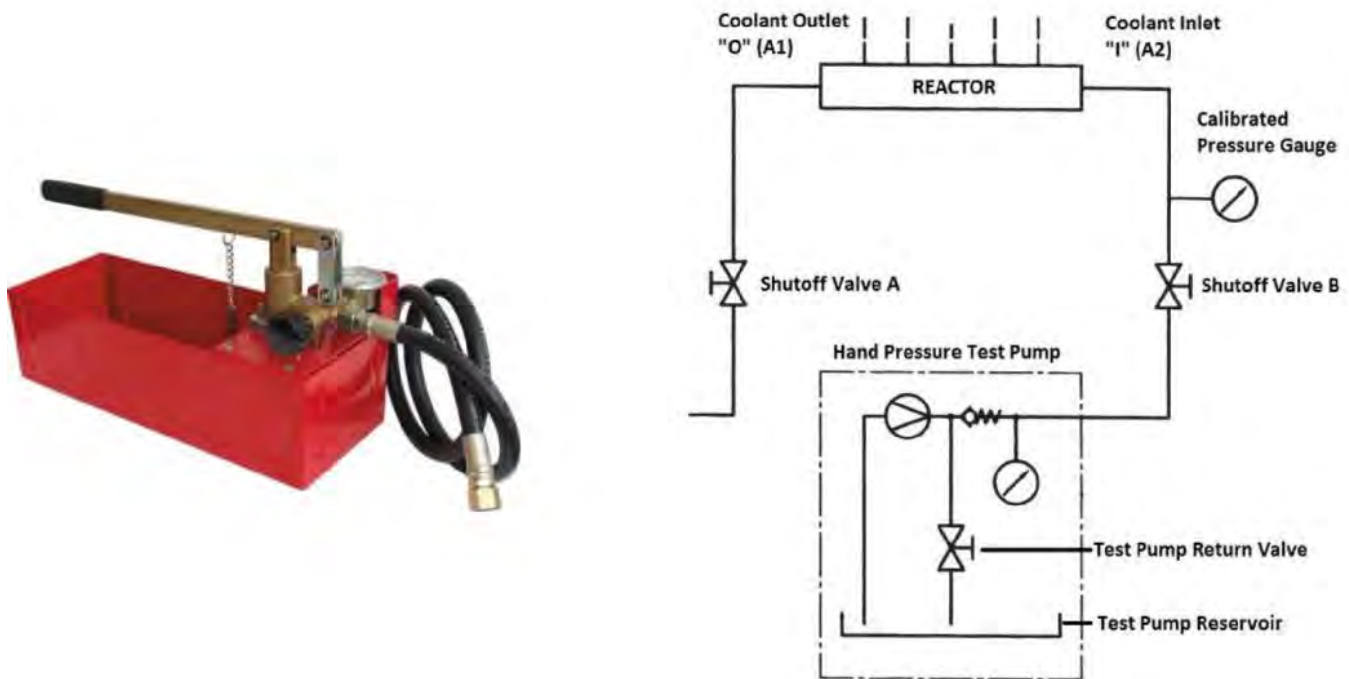


Figure 8. Suitable Hand Pressure Test pump and connection schematic.

With Shutoff Valves A and B open and Test Pump Return Valve closed, the reactor cooling system should be filled from the hand pump reservoir with a 50/50% mixture of water and Glysantine G30 coolant. Depending on the stroke capacity of the hand pump used, this may take some time and It is important to keep the pump reservoir filled and that as much air as possible is purged from the cooling circuit during the filling process. Once a solid coolant flow is emerging from the reactor coolant outlet "O", Shutoff Valve A should be closed and the hand pump used to raise the coolant pressure to 6.0 Bar. Once this pressure is reached, Shutoff Valve B should be closed and the system left pressurized for 30 minutes minimum.

After 30 minutes minimum the reactor should be inspected carefully for the following:

- No pressure drop as indicated by the calibrated pressure gauge.
- No evidence of any leakage or seepage of fluid around any of the hose connection points or anywhere else on the reactor.

If no evidence of the above is observed the system can be carefully depressurized and the reactor drained.

9.2 Electrical testing

WARNING.

The following tests **MUST** be performed with successful results prior to returning the reactor to service. Failure to comply with the above could result in a risk of injury or death.

CAUTION.

The following tests **MUST** be performed with successful results prior to returning the reactor to service. Failure to comply with the above could result in the reactor being unserviceable and damage to the converter. The reactor must be disconnected from the system GE during the test

After the pressure test the reactor should be tested to verify the condition of electrical insulation. The insulation resistance should be measured using a suitable test set with a 1000VDC capability ("Megger" tester). The reactor's insulation resistance should be measured by applying 1000VDC between:

- Phase to Phase for all combinations for 1.0 minute.
- All Phases to Ground (PE terminal on reactor foot bracket) for 1.0 minute.

The insulation resistance in all cases should be > 3.0 GOhms.

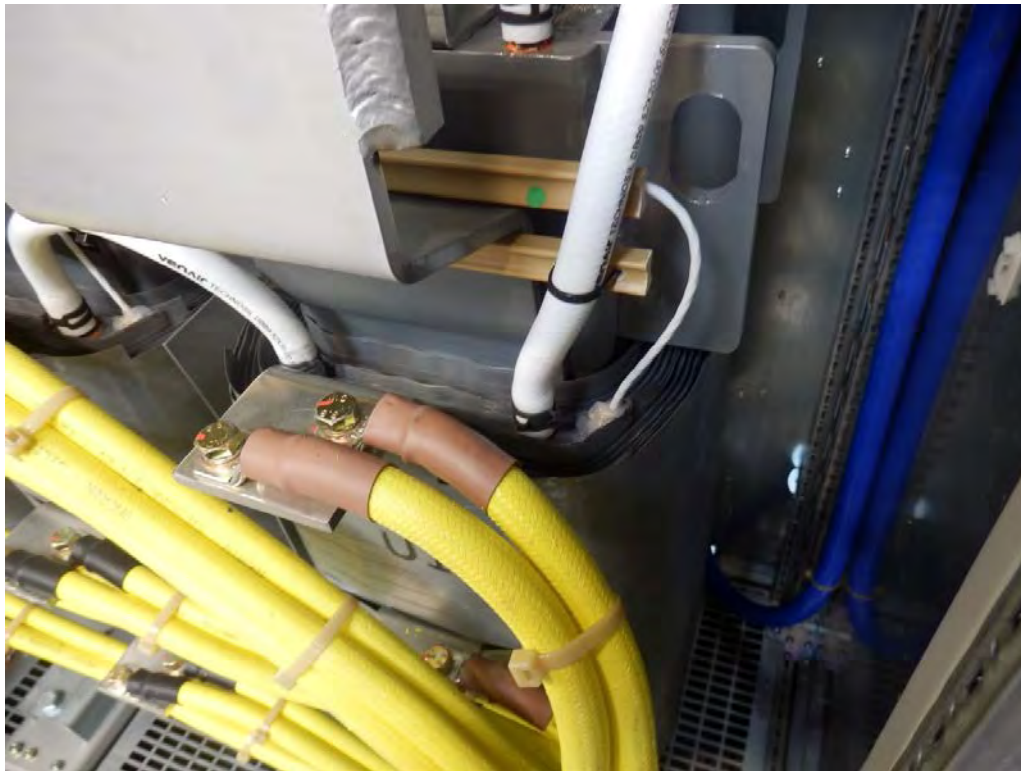
10. Photos of the reactor after replacing the tubes.



Pic. 40



Pic. 41



Pic. 42



Pic. 43



Pic. 44



Pic. 45



Pic. 46



Pic. 47



Pic. 48



Pic. 49



Pic. 50

11. Revision History

Rev.	Date	Author(s)	Changes
00	4/28/2020	Lori Savell	Document Created with AQS