Transactions of the Korean Nuclear Society Spring Meeting
Chuncheon, Korea, May 25-26 2006

Cryogenic Helium Line Routing for In-cryostat Components of the KSTAR

E. N. Bang, Y. M. Park, Y.J. Lee, J. S. Bak
KSTAR, National Fusion Research Center, 52, Yeoeun-dong, Yusung-ku, Daejeon 305-333, KOREA
bang14@nfrc.re.kr

1. Introduction

The cold components to be cooled down to cryogenic temperatures in the KSTAR tokamak are the SC magnet system with its supporting structure, the current feeder system (SC busline and current lead(CL) system) that transfers the current from the power supply to the magnets, the thermal shield(TS) system that protects the SC components and the cryogenic part of the CL system from ambient radiation. The SC magnet system consists of 16 toroidal field(TF) coils, 4 pairs of central solenoid(CS) coils, and 3 pairs of outer poloidal field(PF) coils [1]. All coils, structures and ICBs are cooled down with the 4.5K supercritical helium(SHe), and all TS are cooled down with the 55K gaseous helium(GHe). The fundamental notion of pipe design is to minimize thermal loss. So all components are cooled and acted well. And the in-cryostat helium line is routed to not interface with the other cold component and theirs helium line [2].

2. In-cryostat helium line

2.1. Helium flow diagram

In-cryostat helium are to be supplied from the helium facilities through two transfer lines connected to the transfer ports C-AuC-00 and C-AlC-00 located at KSTAR main cryostat. In each transfer ports, there are many helium lines as shown in table 1. There are 4 helium manifolds for supply SHe to 16 TF coils and the supply helium are returned to one manifold. The returned helium cooled down again to 4.5 K at a thermal damper by heat exchanging with liquid helium. The heat exchanged helium are supplied again to TF coil structures through 4 SHe manifolds and returned to one manifold. TF structure consists of case and outer inter-structure (OIS). TF structure inlet manifold supplies SHe to TF case, and each TF case outlet manifold is connected to TF OIS cooling line. Each PF coil SHe is supplied from one manifold. The two outlet manifolds of PF03,4 upper/lower coil are returned to U/L cryostat ports, respectively shown in Fig 3. The returned helium of PF03,4 coil pass through thermal damper and the helium line is connected to CS structure. SHe cooled down the PF01~05 coil and CS structure are returned to one manifold. And PF06,7 coil SHe are returned to another manifold. GHe for CTS(VVTS) are supplied from one manifold and returned to 3(2) manifolds. SHe for OCB TS is supplied from one manifold and returned

Table 1. In-cryostat helium line

Port	Subject	Size	No.	Total No.
C-AuC-00 (1200mm)	TF Coil In	32A	4	25
	TF Coil Out	65A	1	
	TF Structure In	32A	4	
	PFU Coil In	20A	7	
	CS Structure In	32A	1	
	CSU34 Coil Out	32A	1	
	CTS, VVTS In	65A	2	
	VVTS Out	32A	2	
	TF Bus In	20A	1	
	TFR Bus In	1/2”	1	
	PFU Bus Out	32A	1	
C-AlC-00 (770mm)	TF Structure Out	65A	1	17
	PFL Coil In	20A	7	
	CSL34 Coil Out	32A	1	
	PF15 Out	65A	1	
	PF67 Out	32A	1	
	CTS Out	32/40A	3	
	PFL Bus Out	20A	1	
	TR Out	1/2”	1	
	OCB TS In	20A	1	

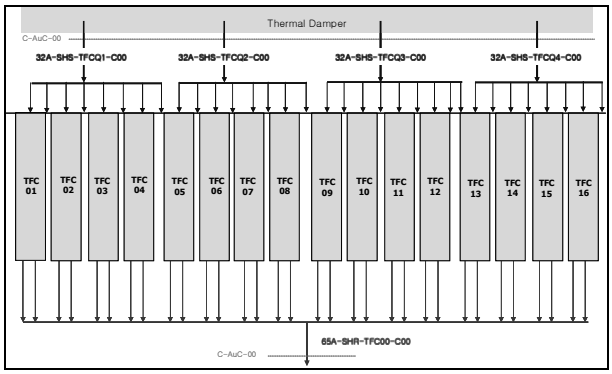

Figure 1 . TF coil flow diagram

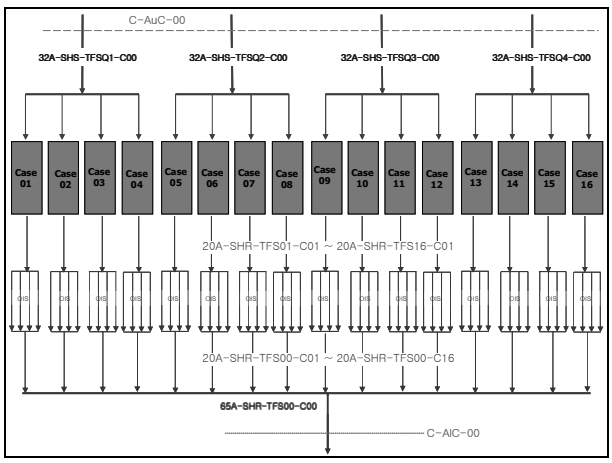

Figure 2. TF structure flow diagram

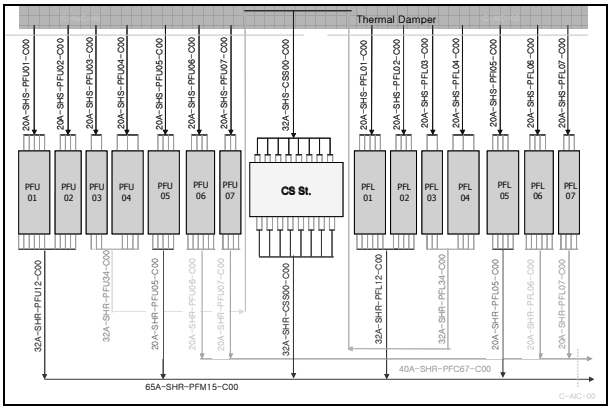

Figure 3. PF coil & structure flow diagram

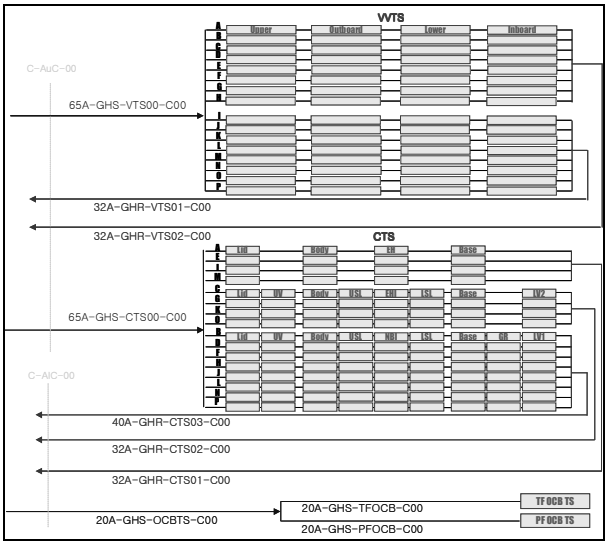

Figure 4. TS flow diagram

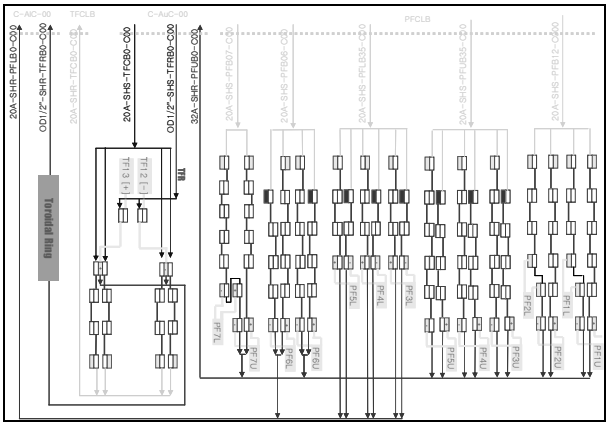

Figure5. TF & PF Busline flow diagram

to CLB. SHe for TF busline is supplied from one manifold and returned to CLB. SHe for TF return busline is supplied and returned with one manifold. TF return busline outlet manifold is connected to toroidal ring inlet manifold. SHe for PF busline is supplied from CLB and returned 2 manifolds.

2.2. In-cryostat helium line routing

TF helium lines are mounted on upper plate of PF6U structure, CS helium lines are on CS coil lead support structure. PF 05 helium lines is mounted on cover plate of PF05 structure, and PF06, 07 helium lines are on wall plate of PF 06, 07 structures, respectively. TS inlet manifolds and VVTS outlet manifolds are mounted under the cryostat lid TS, and CTS outlet manifolds are on cryostat bottom TS. The in-cryostat helium lines for each component are mounted on the support structure of the same components in order to minimize the influence of movement.

3. Conclusion

KSTAR in-cryostat helium line consists of 42 manifolds and four hundreds channels. Fig 6 is shows the 3D drawing the KSTAR in-cryostat helium line routing.

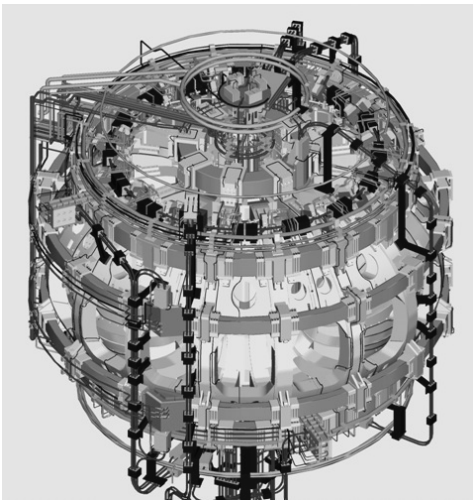

Figure 6. In-cryostat helium line routing 3D drawing

REFERENCES

[1] J.S.Bak, C.H.Choi, H.L.Yang, Key Features and Engineering Progress of the KSTAR Tokamak, IEEE Tran. On Plasma Science, Vol. 32, No.2, pp 757~763, 2004.
[21] E.N. Bang, Y.M.Park, Y.J.Lee, J.S.Bak, The Design of Cryogenic Helium Line for In-cryostat Components of the KSTAR, JKNS, 2004. pp713~714