Cryogenic system for SCC horizontal test

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Abstruct

A cryogenic system for testing Superconducting RF cavity (SCC) in horizontal cryostat has been constructed. Therty-two 5-cell SCC in 16 cryostat for TRISTAN electron positron collider have been tested at the test stand which consist of refrigerator/liquifier(BOC Turbo Cool100: 300W/110litter/hr),1000litter L.He dewar,and transfer lines. In the horizontal test we have comfirmed cryostat performance and cavity performance on low and high RF power.

First horizontal test has been started in December 1987 and last one has been finished in July 1989. During this duration this system has achieved 23 times of hrizontal test and has liquified He for vertical test. And finally all of SCC have succesfully prepared for installation.

Present equipment status and its operation experience of horizontal test will be reported.

Introduction

For energy upgrading the TRISTAN electron positron collider at KEK, installation of 32 5-cell superconducting cavity (SCC) has been proposed and authorized as two year project in April 1986. The construction of all cavities have been finished in September 1989.

Before installation vertical test and horizontal test have been practiced to comfirm the SCC's performance. IN horizontal test SCC and its cryostat which include two 5-cell cavities have been tested under condition of actual use. The test stand which consist of refrigerator/ liquifier (BOC Turbo Cool 100 :300W/110Litter/hr), 1000litter L.He dewar, and transferlines has been constructed for the horizontal test.

Present equipment status and its operation of cryogenic system will be reported.

Horizontal Test

Fig.1[1] shows flow chart of performance tests. On horizontal test followings have been measured.[2]

- -Leakage at L.He temperature
- -Static lossc
- -Loaded Q of fundermental mode
- -External Q of pick up probe
- -Loaded Qof higher order mode
- -Characteristics of HOM coupler
- -Mechanical properties
- -Tuner,Pizo,Tunig loop
- -Eacc max
- -Q_0

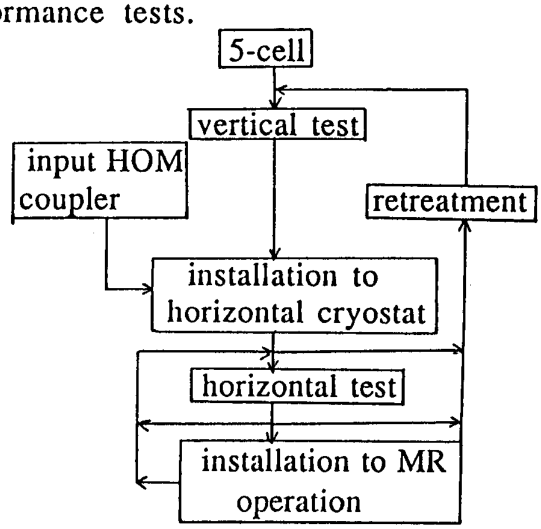


Fig.1

Cryogenic System

In Fig.2 flow dyagram, in Fig.3 view of test area are shown.

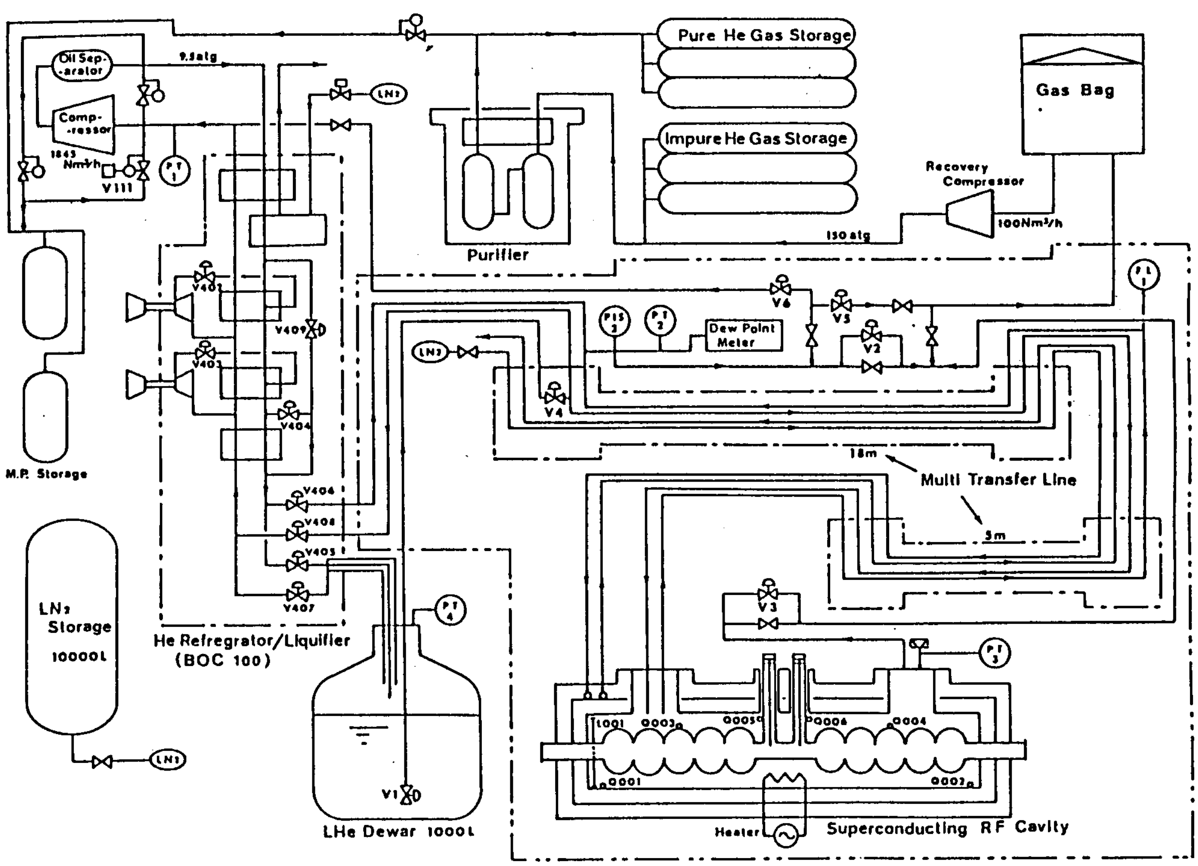


Fig.2

Liquifier, purifier, and 1000litter dewar which had been used for cooling 3-cell superconducting cavity on TRISTAN AR[3] have been moved in January 1987. The other cryogenic parts which mainly consists of transfer lines has been designed in October 1987 and has been constructed in December 1987. Transfer lines consist of Helium supply, return line, and liquid nitrogen supply, return line. main transfer line is multi channel type, and Helium lines have been guarded by liquid nitrogen shield. Fig.4 shows cross section of multi transfer line.

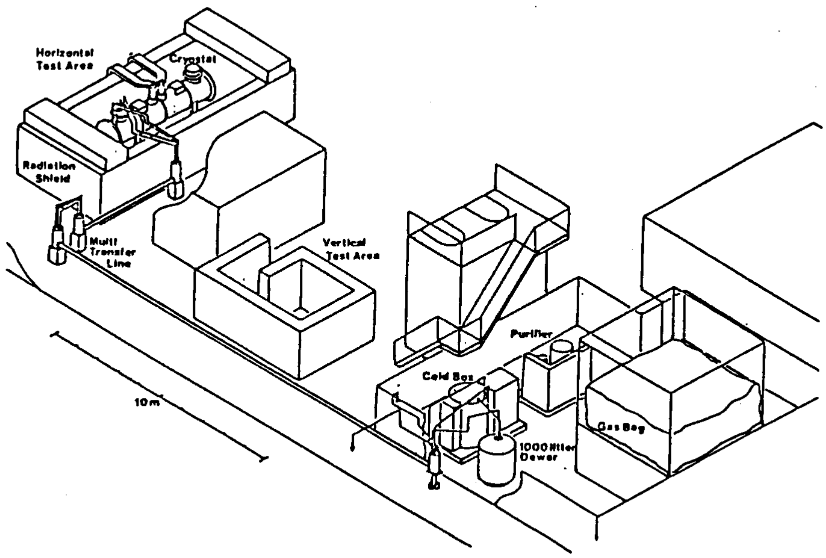


Fig.3

Two relief valve has been constructed to protect SCC from sudden pressure rise. They have been installed at cryostat and Helium return line. They should release Helium gas to gas bag when pressure rose. to above safty pressure.

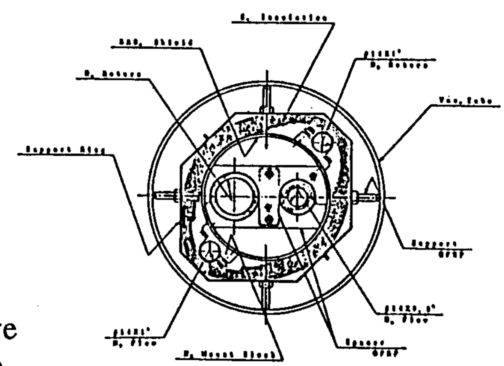


Fig.4

To measure flow rate of low temperature Helium gas from cryostat flow meter has been constructed at Helium return line. For measuring the gas flow, time of flight of high temperature zone which was heated by pulsed heater has been measured by two thermocouples. Fig.5 shows schematic dyagram of flow meter. To convert the time of flight into mass flow rate, Helium gas density was calculated by second order virial equation[4] with temperature and pressure.

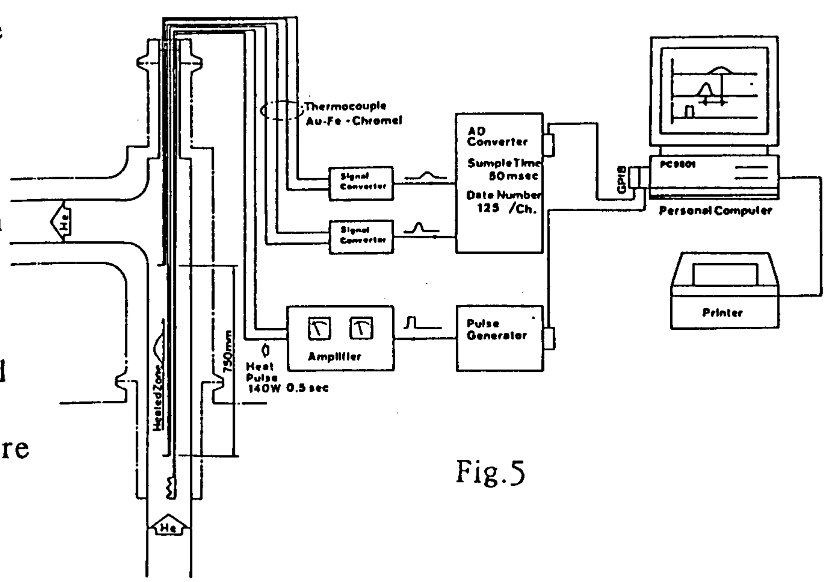
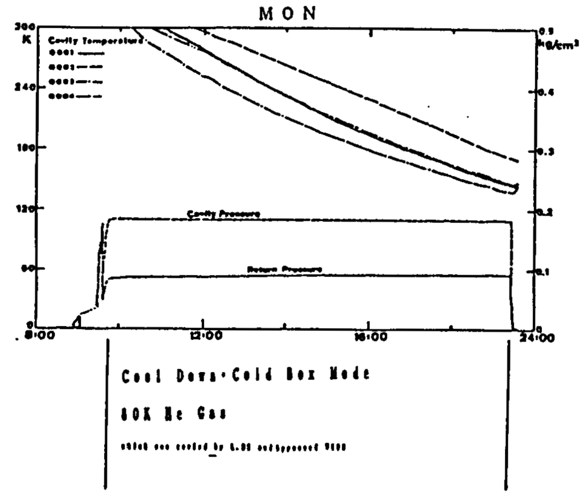


Fig.5

Operation and Test Result

Two weeks have been required for testing one cryostat. One week was for cooling down, filling up liquid Helium, testing, and recovering liquid Helium. Other was for warm up, exchanging to another cryostat, baking beam line, and purging Helium chamber. Fig.6 shows state of cryostat, details of test, and operation modes in the duration from cooling down to recovering.



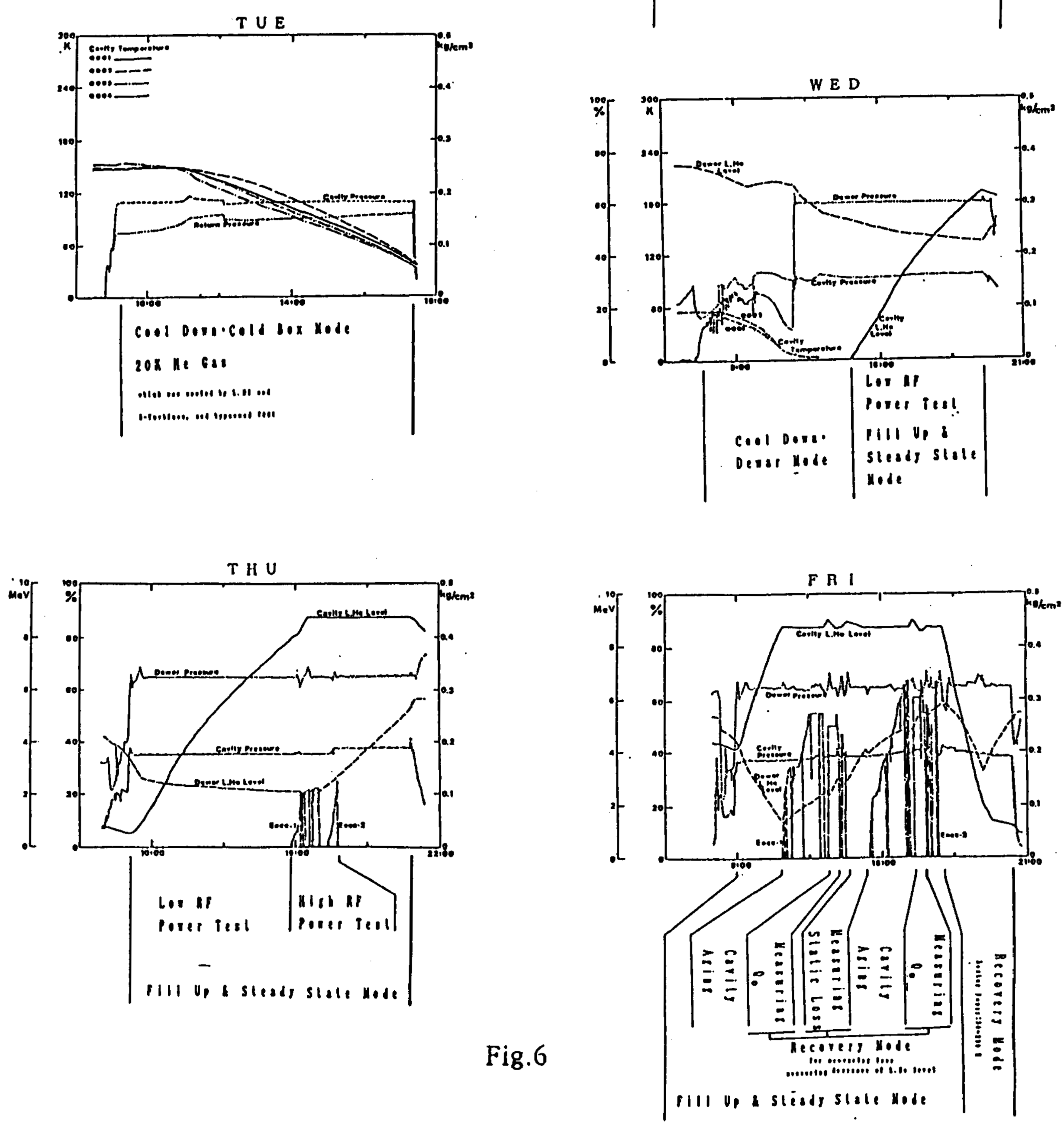


Fig.6

Four operation modes were practiced, and Fig.7 shows operation modes. In cool down-cold box mode cryostat pressure has been controled by JT valve to supply cold Helium gas steadly. In cool down-dewar mode cryostat has been cooled down by liquid Helium which has been supplied from the dewar. The dewar pressure has been controled moderately high rather than cryostat one to supply liquid Helium steadly. Also in fill up and steady state mode the dewar pressure has been controled. In steady state mode liquid Helium level of cryostat has been controled. In recovery mode liquid helium supply has been stopped, and liquid Helium in cryostat has been evaporated by heater and re-liquified into dewar. For measuring Q_0 and static loss recovery mode has been introduced without firing heater. Decreasing of liquid Helium level of cryostat has given the total heat load in the cryostat.

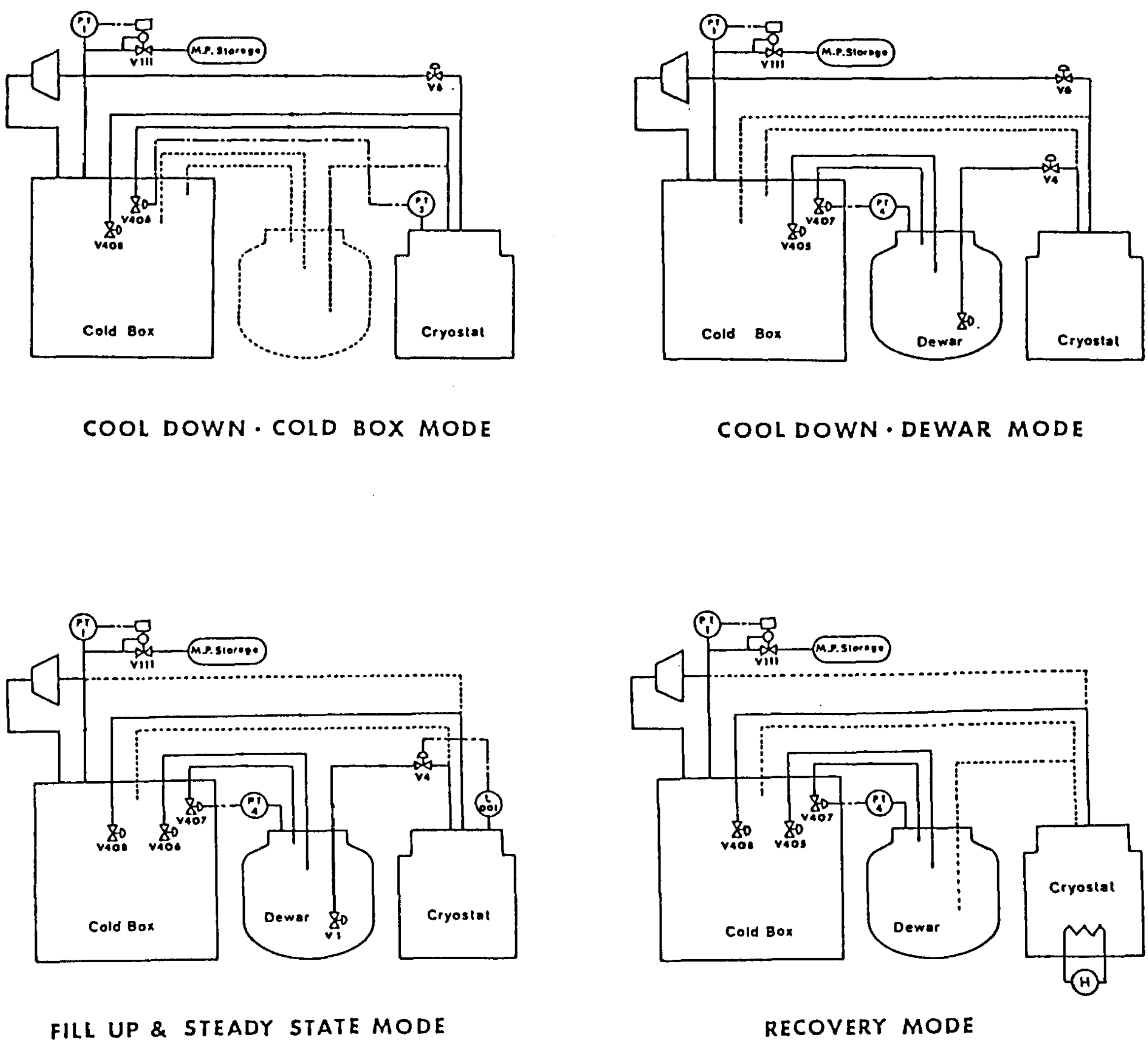


Fig.7

The helium refrigerator has been usually operated only on daytime. And every morning before starting the cavity refrigeration dew point of Helium gas in the cryostat has been comfirmed that it has been under -55 degree centigrade.

Twenty-three times of cooling down has been achieved to prepare 16 cryostat . First test had been started in December 1987 and last one has been finished in July 1989. During this duration refrigerator has been warmed up twice to to purge heat exchanger. Once has been practiced caused by degradation of liquifuction, and other has been practiced with regular inspection.

Cavity break down which occured without quench detection has caused sudden energy disipation owing to Q_0 degradation. The energy disipation has reached about 20 kiro watt, and it caused sudden pressure rise. In the first half of the test quench detecter had not been set up , and RF had been turned off with pressure rise. The relief valve had worked as break down had occured. In the latter half quench detecter has been set up and it has avoided sudden pressure rise. Then the relief valve has worked very few.

The major trouble during the cooling down was vacuum leak of cryostat or cavity. In this case cooling down was stopped and cryostat was warmed up.

The flow meter has been calibrated in recovery mode with changing heater power. Fig.8 shows the result of calibration. Horizontal axes means total heat load, and vertical axes means mass flow rate. The solid line means calculated mass flow by heat load. It should be said that the flow meter has measured accurate value in the duration from 1 to 7 g/sec. Available temperature was under 20 K, upto 20 K difusion of high teperature zone was too fast to measured.

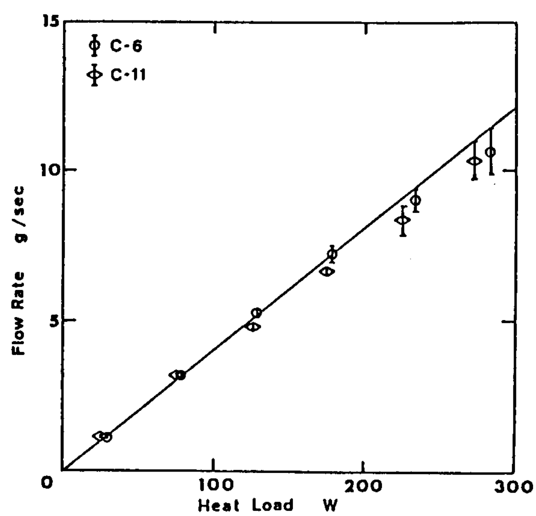


Fig.8

In steady state mode without RF or heater, flow rate of Helium return line gave sum of overall heat load of supply transfer line, static loss of cryostat, and flash loss. The static loss had been measured by other method, and flash loss was able to be calcurated. The overall heat load of supply transfer line was given about 25 watt. The heat load of return line of multi transfer line was calculated from temperature at both end of 18 m multi transfer line and flow rate of Helium return line. It was given about 0.2 watt/m.

Conclusion

All of sixteen cryostat with two 5-cell cavities has been comfirmed its performance in horizontal test, and they were succesfully installed at TRISTAN in this summer. The cryogenic system for horizontal test has been achieved 23 times of cooling down. In this duration the performance test of the system and its components which are mainly transfer line and flow meter has been comfirmed.

Acknowledgement

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