National Centre for Radio Astrophysics

Internal Technical Report

GMRT/ELE/001-Jan 2013

GMRT Central AC plant heat load capacity Test

Authors

R.V.Swami

Email: swami@ncra.tifr.res.in

Objective: To check the feasibility of central AC plant capacity for additional Correlator load.

Revision	Date	Modification/ Change
Ver. 1	* Jan 2013	Initial Version

1. Introduction

GMRT has a central AC plant which is feeding conditioned air to Correlator room and Receiver room to maintain the temperature for working the machines efficiently in these rooms.

Central AC plant details

Plant type	:	Direct Expansion central air conditioning plant
Compressor rating	:	40TR (2No.s, one running & one standby)
Refrigerant	:	R-22
Condenser	:	2 No.s (Water cooled)
Cooling tower	:	40TR capacity (1 No.)
AHU details	:	Cooling coil of 6 rows((13000CFM)
Air velocity	:	1500ft/min.
Air flow rate at AHU canvas	:	not measured
Plant protection system	:	Interlock between cooling tower fan motor and condenser pump motor Interlock between compressor motor and condenser motor Interlock between Compressor motor and AHU motor Interlock between Compressor I and II . Single phasing and phase sequence reversal protection for all the motors.
Refrigeration circuit protection system (Compressor trip settings For)		
Low suction pressure	:	36 Psi
High Discharge pressure	:	250Psi
Ducts (number & Sizes)		
Supply air ducts for Correlator room	:	2 No.s
Supply air ducts for Receiver room	:	2 No.s
Ducts opening area cross section	:	19”X18”

Air flow in Correlator room	:	a) supply air grills , b) return air grills

Inlet /supply air grills in flooring	:	11”x11” (6 No.s)
Outlet /return air grills in shielded roof	:	11”x11” (10 Nos)
Set temp	:	17.5 Degrees

2. **Aim of test**

To check feasibility of central AC plant capacity for additional Correlator load. Test was carried out on 19th Dec 2012 and 7th Jan 2013.
Tests with different arrangements in Correlator room were carried out on two different days.

3. Design description **/ Arrangements for tests**

On 19th Dec 2012, following arrangements was done for carrying heat load test

- 4KW heat load of halogen lamps : 5 sets were prepared and kept in different locations with respect to inlet and outlet air vents.
- Each load was switched ON and temp measurements were taken. Same manner inlet and outlet vents were opened
- In steps of 4 KW total heat load was switched ON , (Full load 20KW) .

Following observations were noted

a) With 12 KW heat load plant runs in normal mode.
b) With increasing load in Correlator room beyond 15KW frosting on refrigerator Suction line, close to cooling coil and on compressor suction side was observed. Compressor suction pressure become low and some time compressor was tripped.
c) Temp on return air side behind GSB rack went up to 28 deg C.
d) Maximum conditioned air was coming from grill in false floor close to Heat load sets rather from grill close to GSB racks. Short cycling of conditioned air was observed.

One more test was carried out on 7th Jan 2013

With previous experience we have changed test procedure, as mentioned below .

- Inlet and outlet grills were opened as shown in drawing to avoid short cycling of conditioned air.
- Maintained temp @ 25 deg behind GSB rack for total test period.
- Thermometers were fixed at following locations like; heat load locations, out let grills in roof, inlet grills/ dummy opening of tiles in false flooring and various locations in Correlator room as shown in drawing. AHU room return air and supply air (in front of coil and canvas)temp were measured at every 15 min interval .
- Please see the temperature table with drawing shown below.
- In A C Plant parameters recorded, like Compressor loading-unloading stages, suction & discharge pressures, AHU room and canvas temp.
- heat load adding in AHU etc. at same intervals of time. Please see the table for Central Plant parameters
- Test started at 11:30 hrs, 7th Jan 2013.
- Please see the table " Correlator Room Heat Load test details" in separate attachment sheet

- Full load of 27 KW in addition to existing GSB rack load of 17KW and Receiver room load of 8 KW were put on Plant. Plant was running without tripping Compressor. Whenever frosting was observed on cooling coil set temp was increased by 0.5 deg. Final set temp at 16:00hrs was 20.5 deg.

Correlator Room Heat Load test details

Sr. No.	Date & Time in hrs	Action	Observation	Remarks
	7th Jan 2013 11:30 hrs			Temp behind GSB rack was maintained @ 25 deg. (* location in drg)
1	11.45	Initially noted down all thermo meters reading before switch on the heat load in Correlator room	The compressor was loaded 25%.	No frosting on suction line
2	11.50	Opened two tiles near the load , inlet ducts(1 & 2) & outlet ducts (A,B,F,G & I) and switched on 4KW load bank-1 & Fans which were in front of GSB rack. Temperature readings in Correlator lab & AC plant parameters has noted down. Microprocessor controller temp Set point was set at 18, initially it was 17.5 deg C .	The compressor was loaded 25%.	Load - existing load of 17KW +4 KW added
3	12:00	Temperature readings in Correlator lab & AC plant parameters were noted down.	The compressor was loaded 100%.	
4	12:15	Switched on 4KW load bank-2 and 1KW load in AHU room. Temperature readings in	The compressor was loaded 25%.	Load - existing load of 17KW +8 KW in corr room + 1KW in AHU added as minor frosting

		Correlator lab & AC plant parameters were		observed on suction line
5	12:30	Temperature readings in Correlator lab & AC plant parameters were noted down.	The compressor was loaded 75%.	frosting observed on suction line
6	12:45	Switched on 4KW load bank-3 and Plenum Heater (6KW) in AHU room. Temperature readings in Correlator lab & AC plant Parameters were noted down.	The compressor was loaded 100%.	Load - 17KW+12KW in Corr lab + (6+1)KW in AHU room added to avoid frosting
7	13:00	One more tile was opened near by the load bank and an outlet duct(J) was opened. Temperature readings in Correlator lab & AC plant parameters were noted down.	The compressor was loaded 75%.	*Frosting on suction line observed and to maintain suction pressure above low suction trip level
8	13:15	Switched on 4KW load bank-4. Temperature readings in Correlator lab & AC plant	The compressor was loaded 75%.	No frosting on suction line
9	13:30	Temperature readings in Correlator lab & AC plant parameters were noted down.	The compressor was loaded 100%.	No frosting on suction line
10	13:45	Switched on 4KW load bank-5. Temperature readings in Correlator lab & AC plant parameters were noted down. Set point was	The compressor was loaded 100%	*Frosting on suction line observed
11	14:00	One more outlet duct(H) was opened. Temperature readings in Correlator lab & AC plant parameters werenoted down.	The compressor was loaded 25%.	No frosting on suction line
12	14:15	Temperature readings in Correlator lab & AC plant parameters were noted down.	The compressor was loaded 75%.	No frosting on suction line
13	14:30	Temperature readings in Correlator lab & AC plant parameters were noted down.	The compressor was loaded 50%.	*Frosting on suction line observed and to maintain suction pressure above low suction

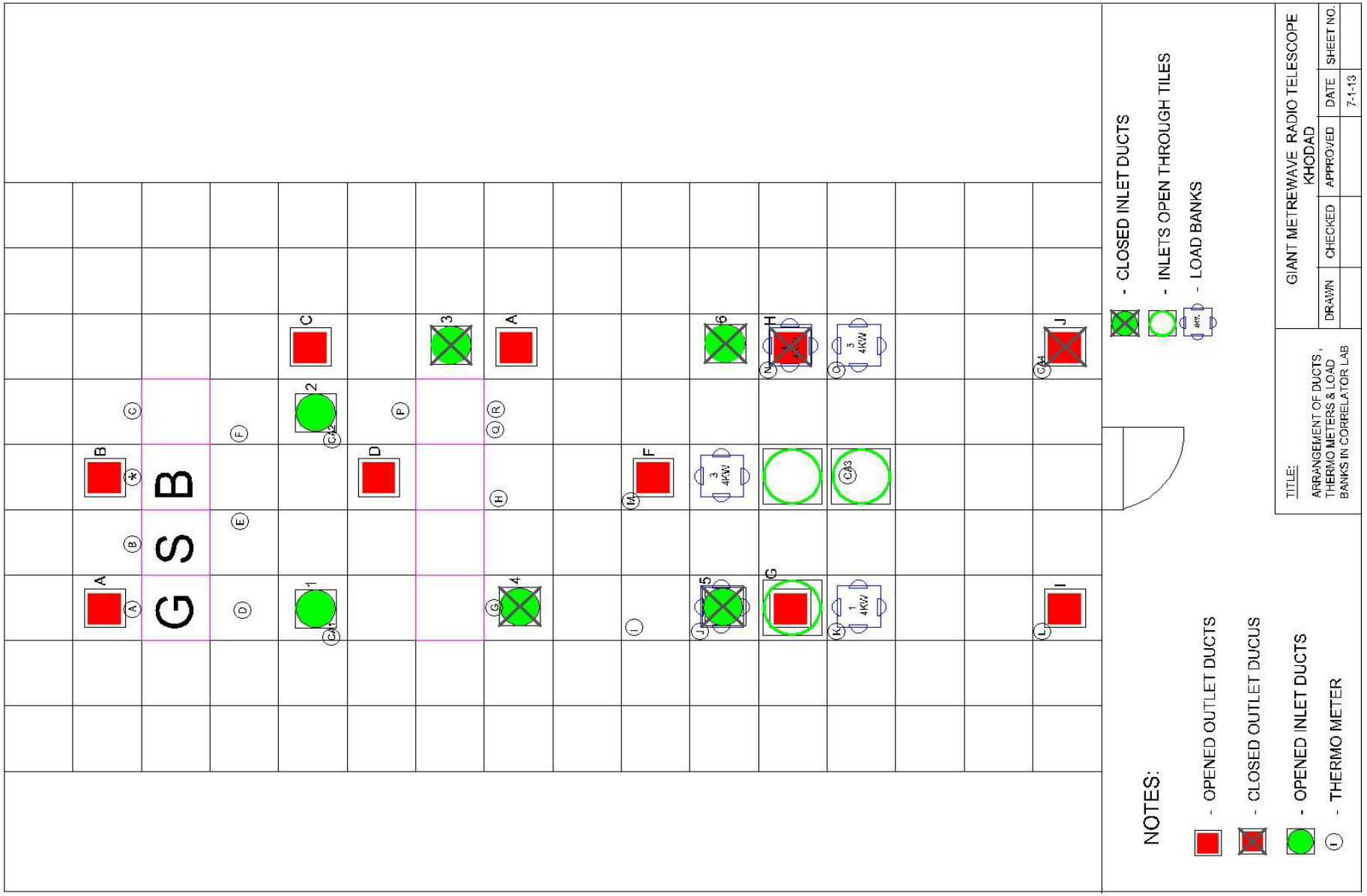
		*Set point was changed to 20.		trip level
14	14:45	Temperature readings in Correlator lab & AC plant parameters has noted down.	The compressor was loaded 25%.	No frosting on suction line
15	15:00	Outlet duct (E) was opened partially. Temperature readings in Correlator lab & AC plant parameters has noted down.	The compressor was loaded 75%.	minor frosting on suction line
16	15:15	Temperature readings in Correlator lab & AC plant parameters have noted down. *The fans in front of GSB rack were switched OFF.	The compressor was loaded 100%.	* To understand changes in temp behind GSB rack
17	15:30	15.30 Hrs to 17.00Hrs Temperature readings in Correlator lab & AC plant parameters were noted down for every 15mins. The compressor was loaded and unloaded properly during this period.	The compressor was loaded 75%.	Temp behind GSB rack gone down to 23 deg from 25 deg.

4. Design validation

18	15:45	Temperature readings in Correlator lab & AC plant parameters were noted down	The compressor was loaded 75%.	Temp behind GSB rack gone down to 23 deg from 25 deg.
19	16:00	Temperature readings in Correlator lab & AC plant parameters were noted down *Set point was changed to 20.5.	The compressor was loaded 75%.	*Frosting on suction line observed and to maintain suction pressure above low suction trip level
20	16:15	Temperature readings in Correlator lab & AC plant parameters were noted down	The compressor was loaded 75%.	very little frosting on suction line
21	16:30	Temperature readings in Correlator lab & AC plant parameters were noted down	The compressor was loaded 75%.	very little frosting on suction line
22	16:45	Temperature readings in Correlator lab & AC plant parameters were noted down	The compressor was loaded 25%.	no frosting on suction line
23	17:00	Temperature readings in Correlator lab & AC plant parameters were noted down	The compressor was loaded 100%.	No frosting on suction line

GMRT Central A C plant Heat Load Capacity Test

Drawing for 7th Jan testing



Central AC Plant parameters record for test period

Temperature readings during heat load test in Correlator Room

Date: 07/01/2013

Date: 07/01/2013	Compressor parameters					AHU Room temp		Heat load added in AHU room if any		Micro Controller Setting
Time in hrs	Suction press.	Discharge press.	Compressor Loading stages			Canvas	Return air			
			1	2	3			AHU room	Plenum heater ON/OFF	Temp Set Point
11:30	62	209	U	U	U	4.6	15.6	NO	NO	17.5
11:45	69	200	U	U	U	8.9	15.5	NO	NO	18
12:00	46	224	L	L	L	4.1	15.5	NO	NO	18
12:15	62	210	U	U	U	8	15.5	1KW	NO	18
12:30	46	235	L	L	U	3.9	15.6	1KW	NO	18
12:45	51	232	L	L	L	5.8	15.8	1KW	6KW	18
13:00	46	245	L	L	U	3.2	15.6	1KW	6KW	18.5
13:15	46	234	L	L	U	4.1	15.8	1KW	6KW	18.5
13:30	36	214	L	L	U	3.4	15.8	1KW	6KW	18.5
13:45	48	220	L	L	L	6.2	16	1KW	6KW	19.5
14:00	45	217	L	L	L	4.6	16.2	1KW	6KW	19.5
14:15	39	217	L	L	U	3	16.1	1KW	6KW	19.5
14:30	58	198	L	U	U	7.5	16.3	1KW	6KW	20
14:45	64	195	U	U	U	8.9	16.1	1KW	6KW	20
15:00	45	200	L	L	U	3.8	16.3	1KW	6KW	20
15:15	47	209	L	L	L	3.2	16.1	1KW	6KW	20
15:30	43	196	L	L	U	3.4	16.4	1KW	6KW	20
15.45	43	200	L	L	U	3.3	16.1	1KW	6KW	20
16	42	204	L	L	U	3.5	16.3	1KW	6KW	20.5
16.15	46	203	L	L	U	3.7	16.5	1KW	6KW	20.5
16.3	46	202	L	L	U	3.7	16.5	1KW	6KW	20.5
16.45	58	188	U	U	U	8.2	16.3	1KW	6KW	20.5
17	61	203	L	L	L	8.7	16.5	1KW	6KW	20.5

Locations of thermometers are shown on drawing starting from backside of GSB rack, Temp of Supply air & return air grills were also recorded.

Time	A	B	*	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	CA1	CA2	CA3	CA4	LOAD
11.35	17	13	21	19	12	15	17	14	15	16	15	16	15	17	17	16	17	20	17	10	11	16	-	OFF
11.45	20	21	21	20	12	15	17	15	15	16	17	16	15	17	17	16	16	19	18	8	9	10	-	4KW
12.00	20	21	25	20	12	15	16	14	15	16	17	15	14	16	17	16	15	19	18	9	10	11	-	4KW
12.15	20	21	26	20	11	15	16	14	14	17	19	16	15	17	17	16	15.6	19	18	7	8	11	-	8KW
12.30	20	20	25	16	10	14	15	14	14	16	19	18	16	16	16	16	14.5	19	18	6	7	9	-	8KW
12.45	20	21	25	17	15	14	15	14	15	17	20	20	17	17	17	16	14.8	19	19	6	7	10	-	12KW
13.00	20	21	26	17	12	16	16	15	15	17	18	17	16	17	17	17	15.2	19	20	9	9	11	-	12KW
13.15	20	21	26	17	11	15	16	15	16	17	18	18	16	17	18	18	15.1	20	20	6	7	10	-	16KW
13.30	20	20	26	16	10	14	15	14	16	17	19	18	16	17	20	18	14.7	20	19	6	6	10	-	16KW
13.45	20	20	26	16	10	14	15	14	15	17	19	18	16	17	19	18	14.5	20	20	5	6	10	19	20KW
14.0	20	21	25	16	10	14	15	15	17	19	21	20	18	17	19	21	15	20	20	6	7	11	20	20KW
14.15	20	21	26	17	10	14	15	15	18	19	20	19	17	20	20	21	14.9	20	21	5	6	11	20	20KW
14.30	20	21	25	18	11	14	16	16	18	20	21	20	18	21	20	23	14.9	20	21	6	7	13	20	20KW
14.45	20	21	26	17	10	14	16	17	19	17	21	19	17	21	20	22	15.9	21	22	7	8	12	20	20KW
15.00	19	21	26	18	10	14	17	17	19	17	20	18	16	21	20	22	16	21	22	8	9	11	20	20KW
15.15	20	23	24	18	11	14	16	18	18	18	21	19	16	20	20	22	15.8	21	23	5	11	9	21	20KW
15.30	20	22	24	18	10	14	14	17	18	19	20	19	16	19	20	22	15.8	21	24	5	11	9	20	20KW
15.45	20	22	23	18	10	14	14	17	17	18	20	20	15	19	19	22	15.5	20	24	5	6	9	20	20KW
16.00	20	22	23	18	10	14	14	17	18	18	20	19	16	19	20	22	15.4	20	20	5	6	9	20	20KW
16.15	20	22.5	23.5	18	10.5	14.5	14	18	18	19	22	21	17	19	21	23	16	21	21	6	7	9	21	20KW
16.30	20	22.5	23.5	18	11	14.5	14	18	18	18	21	20	16	19	21	22	16	21	22	6	6.5	9	21	20KW
16.45	20	23	23.5	18	11.5	15	14	18	19	19	23	21	17	20	21	23	16.2	21	22	7	8	11	21	20KW
17.00	21	22.5	24	19	11.5	15.5	15	18	19	19	23	21	18	20	21	24	16.6	21	22	7	7.5	12	22	20KW

5. Conclusions / **Following observation were noted:**

- **Test was successful :**
  For total load of 52KW (GSB-17KW,Heat load -20KW,AHU- 7KW, Rx room- 8KW, (leakage losses due to frequent opening and closing doors of Corr lab as well as AHU plant room , human load of 5 to 6 persons + lighting of 24 tublights of 40w and 7 incandescent lamps of 60w load are not considered which is coming around 4 to 5KW). The compressor was loaded and unloaded properly with set suction pressure limit throughout the experiment by adding heat load and set temp of plant.

- 90% Ducts for Receiver room were closed still Rx room temp was at 14 deg. for entire test period.

- In corr room inlet ducts in front of GSB were opened and near Heat load area indirect supply air was taken out by opening false flooring tiles (3 tiles were opened as shown in drg.), still GSB temp did not get disturb.

- When switched OFF the fans, temperature behind the GSB rack came down.

- By opening of supply air ducts 2 direct and 3 tiles indirect and 8 and ½ outlets ducts /grills out of 10 in Corr room , GSB temperature was maintained at required set value of 25 deg C .

- In Corr room too much dust below false flooring and on GSB modules. This will block micro-V filters in Plenum and air volume will get reduced. Also dust on GSB PCBs may be harmful.

- Dead racks and cupboards (@25% of room volume) are occupying free space, it reduces free air volume inside room. With existing situation air velocity is on higher side, and conditioned air could not absorb total heat from corr room, cold air is returning to AHU. Please see the temp chart, AHU room temp is not going up even after set temp was increased to 20.5 deg.
- **Test was conducted by Electrical team and AC plant AMC contractor M/s Prajkta Enterprise**
- **Electrical team members : Shri. Bharat Shete(helper)/Shri ARK / Shri. JLG/Shri. E Krishna/Shri. AAD / Shri. BSP/Shri. RVS**
- **Plant Operators : Shri Gulve /Shri. Komte/Shri. Sopan Zurunge**

Central A C plant room

AHU room with cooling coil

Cooling tower

6. Future work

One more test will be carried out during the hot summer to get more realistic results.

7. References : N A