Tele 022-22751134

Naval Trials and Acceptance Authority
c/o Fleet Mail Office
Mumbai 400001

NATAA/300/Ventilation

21 Feb 22

The Officer-in-Charge
Hull Inspection and Trials Unit
c/o Fleet Mail Office
Kochi 682004

The Officer-in-Charge
Hull Inspection and Trials Unit
c/o Fleet Mail Office
Visakhapatnam 520014

The Officer-in-Charge
Hull Inspection and Trials Unit
c/o Fleet Mail Office
Port Blair 744102

VENTILATION TRIALS OF IN-SERVICE SHIPS / SUBMARINES

1. Refer to the following, not addressed to all: -

   (a) IHQ MoD(N)/ DNA letter NC/8333 dated 13 Nov 20, placed at **Enclosure 1**.

   (b) NATAA letter NATAA/318/H dated 21 Dec 21.

   (c) HITU(Mbi) letter HITU/300/39-01 dated 08 Feb 22 and 29 Dec 21, placed at **Enclosure 2** and **3**.

2. IHQ MoD(N)/DNA vide letter ibid had promulgated a standard Ventilation Trials Protocol for conduct of ventilation trials onboard in-service ships based on inputs from all Commands and NATAA. This standard trials protocol consist of aspects wrt commissioning/ design data as well as parameters of AC plants, ATUs/ HEs, etc. including procedure for conduct of ventilation trials in *two* phases namely, habour and sea trials. Further, based on the lessons learnt during conduct of SSC 1 by NATAA of various ships/ submarine at WNC and ENC, it was observed that the ventilation system of machinery compartments has been a neglected area which has led to cascading effect on the performance of various equipment and systems including their control system. Subsequently, to overcome this limitation, NATAA vide letter ibid had directed all HITUs to undertake Machinery Compartment Ventilation System trials as part of Pre and Post Refit trials of ships/ submarines under NR/ MR.

3. At WNC, HITU(Mbi) has commenced undertaking HVAC System trials of all compartments as part of Pre and Post refit trials of ships and submarines undergoing NR/ MR. Further, based on directives from NATAA, HITU(Mbi) has undertaken thorough trials of all compartments onboard INS Delhi as part of Post Refit Trials. The trial reports have been

found to be exhaustive bringing out unambiguous state of the HVAC and machinery compartments ventilation system of the ship.

4. In view of the above, following is requested: -

(a) HITUs to undertake Pre and Post Refit Trials of Ventilation System (HVAC and Machinery Compartments) of all ships/ submarines undergoing NR/ MR.

(b) The trials reports rendered by HITU(Mbi) be perused and the same format may be utilised towards undertaking trials and rendition of reports thereafter.

(Jasvir Singh)
Captain
Addl Director
for Director General

Enclosure: - As above

Copy to: -

The Flag Officer Commanding-in-Chief
(for CCONO/CEO)
Headquarters, Western Naval Command
Mumbai 400023

The Commander-in-Chief
(for CTO (Marine))
Headquarters, A & N Command
Port Blair 744102

The Flag Officer Commanding-in-Chief
(for CCONO/CEO)
Headquarters, Eastern Naval Command
Visakhapatnam 530014

The Flag Officer Commanding-in-Chief
(for CCONO/CEO)
Headquarters, Southern Naval Command
Kochi 682004

Director / Osi/C – DTTT(Vzg), DTTT(Mbi), GTTT(Vzg), GTTT(Mbi), HITU(Mbi), CTT(Pbr).

Internal: - ACOM(D&R) DG NATAA
Cmde(NA) Cmde(ME)

Without Enclosures

Tel 011 - 21410483

एकीकृत मुख्यालय
Integrated Headquarters
रक्षा मंत्रालय (नौसेना)
Ministry of Defence (Navy)
नई दिल्ली-110001
New Delhi -110 001

NC/ 8333

13 Nov 20

The Flag Officer Commanding-in-Chief
(for CSO(Tech))
Headquarters, Western Naval Command
Mumbai 400001

The Flag Officer Commanding-in-Chief
(for CSO(Tech))
Headquarters, Southern Naval Command
Kochi 682004

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Port Blair 744102

VENTILATION TRIAL PROTOCOL FOR IN-SERVICE SHIPS

1. Ventilation system is a mission critical and maintenance intensive system. Optimal functioning of the system is imperative towards exploitation of critical equipment and ensuring habitable standards for crew efficiency.

2. On multiple occasions, sub-optimal performance of ventilation system has been reported by Work Up teams and INWT, even after satisfactory in-house trials by SS/ Refitting authority and Trial agencies. The sub-optimal performance of the ventilation system is quite often on account of defects/ inadequacies emerging out of shortfalls in poor maintenance/ hygiene.

3. Whilst, adequate periodic maintenance routines have been laid down vide MAINTOPs MT-15023, the upkeep of Ventilation system onboard ships continues to remain a challenge. It is imperative to ascertain the defects/ inadequacies, during in-house trials by SS/ Yard and subsequently by HITUs during pre/post refit trials towards ensuring that the refit period is gainfully utilized to address them.

4. With the above premise, a standard ventilation trial protocol, consisting of fields wrt commissioning/ design data as well as parameters of AC plant, ATU/ HEs and compartments to be recorded has been formulated and is placed at enclosure. The salient aspects of the Ventilation Trial Protocol are enumerated in the succeeding paragraphs.

5. **Conduct of Ventilation Trials**. Ventilation Trials are required to be undertaken in two phases. Whilst Phase 1 (Installation checks) is at harbor for system integrity checks & measurement of air flow, Phase 2 (Functional checks) are to be undertaken at sea for overall assessment of ventilation onboard. This protocol is also to be utilized by HITUs/ SS during pre-refit trials to identify defects. These defects are to be projected as SDL/AWRF to Refitting Agencies for liquidation.

6. **Air Balancing**. Air balancing is a critical activity towards ensuring optimal ventilation and temperatures in compartments, and accordingly completion of the same has been included as a pre-requisite in the trial protocol. This activity is time intensive and iterative in nature. Towards this, it is imperative that the activity be jointly undertaken by SS and Refitting agencies prior commencement of Ventilation trials. Record of air flow data by HITUs has also been emphasized in the trial protocol during Phase I. On completion of air balancing, SS are to ensure that the set air balance configuration is maintained.

7. **Comparison with Design Data**. It is prudent that comparison of recorded values is drawn with commissioning/ design data as the same will ensure SS/ Refitting Agencies to target the original values and avoid acceptance of progressive degradation. For ships where original/ design data is not available, the last trials data are to be referred. Further, conformance to pre-requisites followed during commissioning trials with regards to machinery switched on for heat load will ensure accurate assessment.

8. **Record of Relevant Parameters**. Comprehensive audit of subcomponents of the Ventilation system is required to be undertaken by SS and endorsed on the protocol. These are thereafter to be assessed by HITUs during the Ventilation Trials. The protocol also mandates record of parameters in compartments with forced/ natural ventilation. Further, it is imperative to record manning in compartments and A's and A's/ fitment of new equipment in each compartment causing additional heat load.

9 **Instrumentation**. Deficiency of instrumentation viz chill water flow meters & temp gauges at ATU/HEs has been reported by HQST and trial teams. Non-availability of gauges impedes the Ship's/ Yard's capability to assess the efficacy/ performance of the system and localize the defects. On ships where this deficiency is by design, it is prudent that retro-fitment be progressed through modification cases. Further, wherever these instrumentation are fitted by design, the same are required to be maintained and calibrated from time to time so as to provide accurate readings.

10. In view of the above, the following requested:-

(a) HITUs be directed to use the ventilation trial protocol during pre and post refit ventilation trials for ships in NR/MR. HQST/LWTs may utilize the trial report towards assessment of the system during work ups.

(b) Ships entering SR/ESR be directed to utilize the trial protocol towards in-house assessment of the system and project defects.

(c) BoO be formed towards addressing inadequate instrumentation through retro-fitment iaw NO 36/15.

(d) Ships be directed to progress INCATing of sub-components of ventilation system such as temperature gauges, C/W flow meters, filters, AOQC/SOQC valves etc and undertake D787 amendments as necessary. MOs to ensure sufficient stocking.

(e) Continued adherence to preventive maintenance routines specified in MAINTOPs MT-15023.

(f) In-house audits of Ventilation system be undertaken on a quarterly basis. Conduct of whole-ship Ventilation Shramdhaan may be explored.

(आर वि वि वि रत्नाकर/ RVVV Ratnakar)
कप्तान/ Captain
कप्तान (एन ए)/ Captain (NA)

Enclosure. As above

Copy To

The Flag Officer Sea Training
(for CSO)
Headquarters, Flag Officer Sea Training
Naval Base
Kochi 682004

Director General
Naval Trials and Acceptance Authority
C/o Fleet Mail Office
Mumbai 400001

Internal

Cmde (Nav Ops) Cmde(ME) Cmde(FM) Cmde(EE)

For Info

NA/VCNS TA/COM ACOM(D&R)

(Enclosure to IHQ MoD(N)
letter NC/8333/Policy dated 13 Nov 20
(Refers to Para 4)

VENTILATION TRIALS

PHASE I – INSTALLATION CHECKS (AT HARBOUR)

PRE REQUISITES

Ser	Pre-Requisite	Remarks
1.	SS-H to confirm liquidation of all defects of ventilation system during refit and operational availability of ATUs/HEs and other sub-components.	
2.	SS-H to ensure rectification of defects related to Citadel/ APT (doors, hatches and structural defects)	
3.	Completion of in-house air balancing by SS-H and Yard.	
4.	SS-H to be in possession of GRAQs, OEM Manual, previous ventilation trials report.	
5.	SS-H to be in possession of list of A's &A's/ new equipment fitted since last trials/ commissioning.	

DRAFT FORMAT FOR VENTILATION TRIALS PHASE I

INSTALLATION CHECKS (AT HARBOUR) BY HITUs

INS _____ Document No _____

Date of Conduct of Trials _____

Location of Conduct of Trials _____

Occasion for Conduct of Trials and Authority _____

Table 1. Operational Status of Ventilation Equipment (To be furnished by Ship Staff (Hull Dept) to HITUs. The list is indicative and the table is to be filled up for the actual inventory onboard)

Ser	Equipment (SS to add any Eqpt part specific to Ship)	Compt Name Location Deck/ Fr Stn	Status (Ops/ Non- Ops/ Ops with defects)	Remarks
(a)	ATU 1			
(b)	HE 1			
(c)	AFU 1		Validity of AFU Filters	
(d)	Ventilation Fan 1			
(e)	Ventilation Valve 1			
(f)	Ventilation Valve 2			
(g)	Honey Comb Filters		Last Cleaned/ Defects, if any	
(h)	ATU/ HE Filters		Last Cleaned/ Defects, if any	

Ser	Equipment (SS to add any Eqpt part specific to Ship)	Compt Name Location Deck/ Fr Stn	Status (Ops/ Non- Ops/ Ops with defects)	Remarks
(j)	Ducting and ventilation flaps		Last Cleaned/ Defects, if any	
(k)	Temperature Sensors/ Gauges		Last Calibrated	
(l)	Diffusers/ Louvres			
(m)	APT		Details of clusters proved. Defects, if any	
(n)	Citadel		Last proved on _____. Defects, if any.	
(p)	Chalk Test		Last proved on _____ Defects, if any.	
(q)	As & As		Enclose list of As & As since commissioning/ last trials	

Table 2 Random Sample Checks by HITUs (Record condition)

Ser	Parameter	Remarks
(a)	Hygiene of Ventilation Trunking	
(b)	Diffusers/ Louvres	
(c)	Bellows	
(d)	Ventilation Flap/ Dampers	
(e)	Honeycomb filters	
(f)	Insulation/ Lagging	
(g)	ATU/ HE filters	
(h)	Gauges	
(j)	Mushroom Heads	
(k)	AOQC/ SOQC valves	

Table 3. **Air Flow Measurements - Compartments with Forced Ventilation**

Ser	Compt Name	No of Ducts	Air Flow (m/s)	Duct Area (m^2)	Flow Rate at Ducts (m^3/hr)	Total Air Flow in each Compt (m^3/hr)		Remarks (Record any observations and check condition of VentilationTrunking, Diffusers/ Louvres, Bellows, Ventilation Flap/ Dampers, Insulation/ Lagging, AOQC/ SOQC Valves)
						Design	Measured	
(a)	WCs	4						
(b)	Bosun Store	2						
(c)	Compt 3	2						
(d)	Compt 4	1						

* All Design/ Commissioning data is to be endorsed by SS-H for reference of Trials team. Wherever design values not held, data of previous trial report to be utilized.

Table 4. Air Flow Measurements - Compartments with ATU/ HE Supply

Ser	Compt Name	Served by ATU/ HE/ Ventilation Fan	No of Ducts	Air Flow (m/s)	Duct Area (m^2)	Flow Rate at Ducts (m^3/hr)	Total Air Flow in each Compt (m^3/hr)		Remarks (Record any observations and check condition of Ventilation Trunking, Diffusers/ Louvres, Bellows, Ventilation Flap/ Dampers, Insulation/ Lagging)
							Design	Measured	
(a)	Compt 1	ATU ___							
(b)	Compt 2	ATU_							
(c)	Compt 3	ATU ____							
(d)	Compt 4	ATU___							

* All Design/ Commissioning data is to be endorsed by SS-H for reference of Trials team. Wherever design values not held, data of previous trial report to be utilized.

Table 5. Summary

(a)	**Observations (indicative)**
(i)	Insufficient Air flow at Paint store, Machinery workshop Compt
(ii)	Defective diffusers/ ventilation trunking observed at
(b)	**Mitigative Action**
(i)	Air balancing to be undertaken in ATU 3 loop compartments
(ii)	Replacement of defective bellows at xx Compt

VENTILATION TRIALS

PHASE 2 – FUNCTIONAL CHECKS (AT SEA)

PRE REQUISITES

Ser	Pre-Requisite	Remarks
1.	SS-H to ensure liquidation of all observations of Ventilation trials Phase I	
2.	SS-H to ensure operational availability of all ATU/ HEs.	
3.	SS-E to ensure completion of installation checks/ trials of AC plants and CW system.	
4.	SS-E to ensure completion of ventilation trials of machinery compartments	
5.	Trial to be undertaken in summer environmental conditions and at sea.	
6.	SS-E/L/H to ensure all machinery/ equipment contributing to Heat Load (as mandated in commissioning trials) switched on during trials	

VENTILATION TRIALS PHASE 2
FUNCTIONAL CHECKS (AT SEA)

INS _____ Document No _____

Date of Conduct of Trials _____

Location of Conduct of Trials _____

Occasion for Conduct of Trials and Authority _____

Table 1. Ambient Conditions

Regime	Sea Water Temperature(°C)		Atmospheric Temperature (°C)		Atmospheric Relative humidity (%)		Remarks
	1200 HRS	1600 HRS	1200 HRS	1600 HRS	1200 HRS	1600 HRS	
Sea (Action station/ Battle station/ Cruising station)							

Table 2. **AC Plant Data** (SS-E to assist HITUs in record of these parameters. D- Design, A- Actual)

Ser	AC Plant No	CW Inlet Temp (°C)		CW Outlet Temp (°C)		Chilled Water Flow (m^3/hr)	
		D	A	D	A	D	A
(a)	AC Plant 1						
(b)	AC Plant 2						
(c)	AC Plant 3						
Total No of AC plants running		Design/ Commissioning _____		Trial day_____			

Table 3. **Chilled Water Measurements at ATU/ HE**

Ser	ATU/ HE No	Fed by AC Plant	Chilled Water Flow (m^3/hr)		Chilled Water Temp (°C)				Remarks (Record any observations and check ATU hygiene and condition of sub -components – cooling coil, gauges, insulation, ATU/HE Filters etc)
			Design	Actual	Inlet		Outlet		
					D	A	D	A	
(a)	ATU 1								
(b)	HE 1								
(c)	ATU 2								
(d)	ATU 3								

* All Design/ Commissioning data is to be endorsed by SS-H for reference of Trials team. Wherever design values not held, data of previous trial report to be utilized.

Table 4. Record of Values in Compartments

Ser	Compt Name	Occupancy		Fed by ATU/ HE	Fed by AC Plant No	Temp (°C)				Relative Humidity (%)		Record details of new Eqpt fitted in Compt since commissioning causing additional Heat Load	Remarks
						Dry Bulb		Wet Bulb					
		Design	Actual			D	A	D	A	Design	Measured		
(a)	Compt 1			ATU___									SAT/
(b)	Compt 2												
(c)	Compt 3												UNSAT
(d)	Compt 4			ATU___									

* All Design/ Commissioning data is to be endorsed by SS-H for reference of Trials team. Wherever design values not held, data of previous trial report to be utilized.

Table 5. Summary

(a)	**Observations (indicative)**
(i)	Higher than design temp observed in Wardroom, Ships office etc
(ii)	Defective temp gauges in ATU 2
(b)	**Mitigative Action**
(i)	Cleaning of coils of ATU 6
(ii)	Replacement of dust filters of ATU 9

(Enclosure to IHQ MoD(N)
letter NC/8333/Policy dated 13 Nov 20
(Refers to Para 4)

VENTILATION TRIALS

PHASE I – INSTALLATION CHECKS (AT HARBOUR)

PRE REQUISITES

Ser	Pre-Requisite	Remarks
1.	SS-H to confirm liquidation of all defects of ventilation system during refit and operational availability of ATUs/HEs and other sub-components.	
2.	SS-H to ensure rectification of defects related to Citadel/ APT (doors, hatches and structural defects)	
3.	Completion of in-house air balancing by SS-H and Yard.	
4.	SS-H to be in possession of GRAQs, OEM Manual, previous ventilation trials report.	
5.	SS-H to be in possession of list of A's &A's/ new equipment fitted since last trials/ commissioning.	

DRAFT FORMAT FOR VENTILATION TRIALS PHASE I

INSTALLATION CHECKS (AT HARBOUR) BY HITUs

INS _____ Document No _____

Date of Conduct of Trials _____

Location of Conduct of Trials _____

Occasion for Conduct of Trials and Authority _____

Table 1. Operational Status of Ventilation Equipment (To be furnished by Ship Staff (Hull Dept) to HITUs. The list is indicative and the table is to be filled up for the actual inventory onboard)

Ser	Equipment (SS to add any Eqpt part specific to Ship)	Compt Name Location Deck/ Fr Stn	Status (Ops/ Non- Ops/ Ops with defects)	Remarks
(a)	ATU 1			
(b)	HE 1			
(c)	AFU 1		Validity of AFU Filters	
(d)	Ventilation Fan 1			
(e)	Ventilation Valve 1			
(f)	Ventilation Valve 2			
(g)	Honey Comb Filters		Last Cleaned/ Defects, if any	
(h)	ATU/ HE Filters		Last Cleaned/ Defects, if any	

Ser	Equipment (SS to add any Eqpt part specific to Ship)	Compt Name Location Deck/ Fr Stn	Status (Ops/ Non- Ops/ Ops with defects)	Remarks
(j)	Ducting and ventilation flaps		Last Cleaned/ Defects, if any	
(k)	Temperature Sensors/ Gauges		Last Calibrated	
(l)	Diffusers/ Louvres			
(m)	APT		Details of clusters proved. Defects, if any	
(n)	Citadel		Last proved on _____. Defects, if any.	
(p)	Chalk Test		Last proved on _____ Defects, if any.	
(q)	As & As		Enclose list of As & As since commissioning/ last trials	

Table 2 **Random Sample Checks by HITUs (Record condition)**

Ser	Parameter	Remarks
(a)	Hygiene of Ventilation Trunking	
(b)	Diffusers/ Louvres	
(c)	Bellows	
(d)	Ventilation Flap/ Dampers	
(e)	Honeycomb filters	
(f)	Insulation/ Lagging	
(g)	ATU/ HE filters	
(h)	Gauges	
(j)	Mushroom Heads	
(k)	AOQC/ SOQC valves	

Table 3. **Air Flow Measurements - Compartments with Forced Ventilation**

Ser	Compt Name	No of Ducts	Air Flow (m/s)	Duct Area (m^2)	Flow Rate at Ducts (m^3/hr)	Total Air Flow in each Compt (m^3/hr)		Remarks (Record any observations and check condition of VentilationTrunking, Diffusers/ Louvres, Bellows, Ventilation Flap/ Dampers, Insulation/ Lagging, AOQC/ SOQC Valves)
						Design	Measured	
(a)	WCs	4						
(b)	Bosun Store	2						
(c)	Compt 3	2						
(d)	Compt 4	1						

* All Design/ Commissioning data is to be endorsed by SS-H for reference of Trials team. Wherever design values not held, data of previous trial report to be utilized.

2854
10 Feb 22

Tele: 22751345

Hull Inspection and Trials Unit
C/o Fleet Mail Office
Mumbai - 400 001

HITU/300/39-01

08 Feb 22

The Commanding Officer
(for Executive Officer)
INS Delhi
c/o Fleet Mail Office
Visakhapatnam - 530014

VENTILATION TRIALS – INS DELHI

1. Refer to the following: -

(a) INS Delhi fax 343/14/10 dated 04 Jan 21.
(b) Def Stan 02-102 Part 1 Issue 2 (2000) - NES 102.
(c) GRAQS documents of Ventilation System – INS Delhi.

2. INS Delhi vide fax ibid had offered post refit ventilation trials to HITU(Mbi). Accordingly, HVAC trials of 142/175 compartments (offered till date) were undertaken progressively between Dec 21 – Jan 22 and details of the same are elucidated in subsequent paragraphs.

3. **Guidelines for Trials**. The following reference documents were referred during the conduct of ventilation trials: -

(a) Design values indicated in the GRAQS of Ventilation and Air Conditioning System – INS Delhi.
(b) NES 102 - Design of HVAC system.

4. **Checks**. Following checks were undertaken in accordance with extant policy guidelines:-

(a) The number of AC plants running are in accordance with the trial requirement and ship condition.
(b) AC discipline could not be maintained effectively view ongoing repair activities onboard ship.
(c) All equipment required to be operated for trials were not switched on view ongoing repairs.
(d) Manning plan of the compartments as per the 'Design manning plan' was ensured by ship staff to the extent feasible.
(e) All components of ventilation and air conditioning system were switched on during the trials and found operational.

5. **Design Parameters**. The following have been considered as design parameters based on available documentation and NES 102:-

(a) Ship's exploitation under following environment conditions:-

Dry Bulb Temperature	Relative Humidity (%)
30 °C to 35 °C	Not Greater than 70%

(b) The following were considered as acceptable limits iaw NES 102:-

Ser	Compartment	Effective Temp. (°C)	Relative Humidity (%)	Reference Document
(i)	Galleys	25.5	30-65	NES 102 - Requirements for AC and Ventilation
(ii)	Other compartments	23.5	45-65	

6. **External Environment Conditions during Trials**. It may be noted that ambient environment parameters during the trials were generally lower than design ambient parameters as per NES 102. Therefore, performance of the system is expected to be at variance from the recorded values when subject to higher ambient temperatures. The external environment parameters measured during the course of the trials are as follows:-

Date	Time (Hrs)	Dry Bulb Temp (°C)	Wet Bulb Temp (°C)	Effective Temp (°C)	RH (%)
23 Dec 21	1130	28.5	24.9	26.9	74.9
27 Dec 21	1100	28.5	23 .5	26.6	66
28 Dec 21	1530	27.5	22.5	26.2	65.3
04 Jan 22	1100	31	25	28.5	61.8
06 Jan 22	1200	29	24	27	66.3
07 Jan 22	1100	26	21.8	24.3	69.5
10 Jan 22	1100	26.4	19.6	24.1	53.3
17 Jan 22	1115	27.3	22.7	25.8	67.7
24 Jan 22	1100	24.8	18	22.2	49.5
27 Jan 22	1500	28.4	21.4	26.2	54

7. **Ship Condition during Trials**.

(a) Manning of compartments was ensured by ship staff.

(b) 01 - 02 out of 06 AC plants were running during the trials.

8. **Data Recorded**.

(a) **AC Chilled Water Temperature**. Temperatures at the ACs were recorded by means of infrared temperature sensor gun. The chilled water inlet and outlet temperatures of the respective ACs are placed at Enclosure.

(b) **Temperatures**. Dry Bulb (DB) and Wet Bulb (WB) temperatures were measured in all compartments and the Effective Temperatures calculated and compared with reference documents. The detailed values and inferences are placed at Appendix to Enclosure.

(c) **Air Flow and Relative Humidity**. The volume of air flow from the HEs into the respective compartments and RH values in compartments supplied by HEs are indicated in the detailed HVAC report placed at Appendix to Enclosure.

9. **Inferences**.

(a) **AC Chilled Water Temperature**. The CW temperatures at the outlets of the ACs is higher than the design value of **6°C to 8°C** and varying between **8 - 12 °C** (*as recorded using inbuilt temperature gauge*).

(b) **HEs CW temperatures**. CW temperatures at the inlets of HEs were found to be in the range **14 to 16°C**. Temperature loss of up to 5 - 6 °C was observed between AC plants and HEs.

(c) **Effective Temperatures**. External environmental conditions during the course of trials were lower/ favourable in comparison with the design trial conditions and trials in **54/142** compartments were found to be **SAT in prevailing weather conditions**. The Effective Temperatures measured across the compartments iaw reference documents are placed at Appendix to Enclosure. Summary of results is as follows:-

Total Compartments Supplied with conditioned air from AC Plants	Total Offered	SAT	UNSAT	Remarks
175	142	54	88	- 23 compartments not offered for trials. - Phase II trials pending.

(d) **Relative Humidity**. Relative Humidity in 49/142 compartments was found to be **UNSAT** in prevailing weather conditions.

(e) **Air Flow Measurements**. The air flow was measured to be lower than design values in 69/142 compartments.

Recommendations.

10. The environmental parameters of effective temperature and RH in all compartments of the ship are lower/ favourable in prevailing environmental conditions, therefore, following is recommended for optimum performance of the system: -

(a) Thorough audit of all AC Plants and trials by MTU to check the parameters/ performance of the impellers/ motors directly affecting the supply/ flow of air into the compartments. Therefore it is recommended that the same be examined for DI/DR.

(b) Measurement/ regulation of CW flow across HEs and *setting-to-work* (chilled water balancing) for effective functioning of HEs and ATUs.

(c) Inspection of ventilation trunking for leakages, if any.

(d) Ensure closure of all watertight openings and maintenance of strict AC discipline.

(e) **Re-offer UNSAT compartments** for ventilation trials post successful in-house trails.

(f) Continue maintenance of AC and Ventilation system i.a.w HQWNC letter 300/ 50/ 9/ 1 dated 14 Jan 21.

(Avishek Rehal)
Lieutenant Commander
Trials Officer
for Officer-in-Charge

Encl:- As above.

Copy to:-

The Flag Officer Commanding-in-Chief
(for SCONO)
Headquarters, Western Naval Command
Ballard Pier, Near Tiger Gate
Naval Dockyard, Mumbai - 400023

The Admiral Superintendent
(for SMCAP)
Naval Dockyard
SBS Marg
Mumbai – 400023

The Director
(for Dy. Director)
NATAA
C/o Fleet Mail Office
Mumbai - 400 001

Enclosure to HITU(Mbi) letter
HITU/300/39-01 dated Feb 22

POST REFIT VENTILATION SYSTEM TRIALS - INS DELHI

1. Ship : INS Delhi
2. Date of commission : 15 Nov 1997
3. Occasion : POST MR-MLU
4. Refitting Yard : ND (Mbi)
5. Date of Trials : 23 Dec – 27 Jan 22
6. References : NO 07/18 and NES 102
   GRAQS of Ventilation System – INS Delhi
7. No. of AC plants : 06
8. Make and Model : Voltas
9. Chilled water temperature at AC Plant inlets/ outlets is as follows:-

DATE	AC	CW TEMP IN GAUGE (°C)	
		OUTLET	*INLET*
23 Dec 21	AC PLANT 1	12	15
	AC PLANT 5	11	14
27 Dec 21	AC PLANT 1	8	11
	AC PLANT 3	10	13
28 Dec 21	AC PLANT 1	10	13
	AC PLANT 4	10	12
04 Jan 22	AC PLANT 2	10	13
	AC PLANT 5	11	14
06 Jan 22	AC PLANT 2	9	12
	AC PLANT 5	10	13
07 Jan 22	AC PLANT 4	9	12
10 Jan 22	AC PLANT 5	11	14
17 Jan 22	AC PLANT 3	11	14
24 Jan 22	AC PLANT 3	11	16
27 Jan 22	AC PLANT 5	11	14

10. **Trial Data**. The detailed ventilation trials report is placed at ***Appendix***.

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c/o Fleet Mail Office
Mumbai - 400 001

HITU/300/39-01

29 Dec 21

The Commanding Officer
(for Executive Officer)
INS Delhi
c/o Fleet Mail Office
Mumbai - 400 001

VENTILATION TRIALS OF MACHINERY COMPARTMENTS-INS DELHI (MR-MLU)

1. Refer to NATAA signal DTG 151935/ Nov.

2. Ventilation trials of major machinery compartments viz. Fwd AC, Mid AC, Aft AC, Shaft Alleyway(P & S) and Refrigeration compartment were undertaken by HITU (Mbi) on 21 Nov 21.

3. **Guideline for trials**. Def Stan 02-102, NES 102 and ship's GRAQS.

4. **Design Parameters**. The following have been considered as design parameters based on NES 102:-

(a) Ship's exploitation under following environment conditions (Hot Climates as per NES 102):-

Dry bulb Temperature	Wet Bulb Temperature
35 °C	30 °C

(b) Temperature. Main and large auxiliary machinery spaces, in 'Open Ship' condition, temperature rise above external ambient restricted to 15 °C {as per para 4.1 (d) of section 4 of NES 102}.

(c) Airflow. Since the ship's initial design data for airflow in these compartments is available with SS, the same has been used as reference for the present trials.

5. **External Environment Conditions during Trials**. The external environment parameters measured during the trials were as follows:-

Dry Bulb Temp (°C)	Wet Bulb Temp (°C)	Effective Temp(°C)	RH (%)
28	23	25.5	67

6. **Ventilation Arrangement**. The ventilation arrangement onboard in the above mentioned compartments is as follows:-

(a) Fwd AC. The compartment is provided with two supply and two exhaust blowers. The supply blowers are not fitted with any HE or sea water cooler.

(b) Mid AC. The compartment is provided with one supply and one exhaust blower. Supply blower is not fitted with any HE or sea water cooler.

(c) Aft AC & Shaft Alleyway (P & S). These compartments are fitted with one supply blower and one exhaust blower common for all three compartments. Supply blower is not fitted with any HE or sea water cooler.

(d) Refrigeration compartment. The compartment if provided with one supply and one exhaust blower. The supply blower is not fitted with any HE or sea water cooler.

7. **Trials**. Measurements wrt air flow of supply and exhaust blowers and temperature were recorded for each compartment. Detailed report on the trials is placed at enclosure.

8. **Observations**. Salient observations of the trials are as following:-

(a) Fwd AC.

(i) 01/02 supply blowers was non-operational and data was recorded wrt airflow and temperature. The effective temperature and relative humidity (RH) were calculated to be 29.2 °C and 49%.

(ii) Total supply and exhaust airflow was recorded to be 734.4 m^3/hr and 5348 m^3/hr. The supply airflow is considered to be UNSAT when compared to design flow rate.

(iii) 08 inspection windows were missing at various locations on the ventilation trunking.

(iv) 03 cloth Bellows were missing at indicated locations.

(v) 03 wire meshes were missing on ventilation trunkings at indicated locations.

(b) Mid AC.

(i) Both the blowers were operational and data was recorded wrt airflow and temperature. The effective temperature and relative humidity (RH) were calculated to be 26.6 °C and 49%.

(ii) Total supply and exhaust airflow was recorded to be 7217.06 m^3/hr and 6600 m3/hr which is comparable to the design airflow values and is considered to be SAT.

(iii) 08 inspection windows were missing at various locations on the ventilation trunking.

(iv) 04 wire meshes were missing on ventilation trunkings at indicated locations.

(v) Lagging on exhaust blower was damaged.

(c) Aft AC & Shaft Alleyway (P & S).

(i) Both the blowers were operational, however fresh air intake trunking for supply blower was removed and blanked.

(ii) 01 ventilation trunking was incomplete.

(iii) Exhaust of the Aft AC was not working view sluice valve stuck at closed position.

(iv) Flow rate of exhaust could not be taken view SOQC valve in Stbd Hangar stuck at closed position.

(v) 03 inspection windows were missing at various locations on the ventilation trunking.

(vi) 04 wire mesh of supply blower were missing.

(d) Refrigeration compartment.

(i) Exhaust blower was non-operational and data was recorded wrt airflow (supply) and temperature. The effective temperature and relative humidity (RH) were calculated to be 29.7 °C and 55%.

(ii) 03 inspection windows were missing at various locations on the ventilation trunking.

(iii) 02 wire mesh of supply blower were missing.

9. **Inferences**. The following can be inferred from the trials:-

(a) Airflow. The airflow data recorded during the trials can be considered SAT for Mid AC compt. and UNSAT for all other compartments view non-compliance with the available design data.

(b) Temperature. Although the temperature recorded can be considered **SAT** in Fwd AC, Mid AC and Ref. compartments, it is pertinent to mention that the heat load of the compartments were significantly lesser than what it is expected to be while the ship is out at sea view major machinery not running during the trials and therefore no conclusive inference can be made from the recorded trial data.

10. **Recommendations**. In view of the above, following is recommended:-

(a) SS to project the above mentioned observations to ND(Mbi) for early liquidation.

(b) SS liaise with ND (Mbi) for early liquidation of above mentioned defects.

(c) Conduct of Ventilation trials of machinery compartments to be undertaken in conjunction with the Phase II HVAC trials at sea with full heat load disposition so as to make meaningful assessment of ventilation system in machinery compartments.

(Avishek Rehal)
Lieutenant Commander
Trials Officer
for Officer-in-Charge

Encl:- As above

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The Director General
{for Capt (E)}
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Mumbai- 400 001

Enclosure to HITU(Mbi) letter HITU/300/39-01 dated 29 Dec 21

VENTILATION TRIALS OF MACHINERY COMPARTMENTS- INS DELHI

SER	COMPARTMENT	BLOWER	DUCTS	MEASURED VALUES					DESIGN FLOW RATES(m3/ hr)	TEMPERATURES & RH			
				AIR FLOW (m/s)	DUCT AREA (m^2)	FLOW RATE (m^3/ hr)	TOTAL COMPT. FLOW RATE (m^3/ hr)	TOTAL FLOW RATE (m^3/ hr)	COMPT	DB TEMP °C	WET TEMP °C	EFF. TEMP °C	RH (%)
1	Fwd AC	Supply Blower(P)	2	2.20	0.0600	475.20	734.40	734.40	3,100.00	32.5	24.5	29.2	49
				1.20	0.0600	259.20							
		Supply Blower(S)	Non Ops										
		Exhaust Blower(P)	1	3.90	0.1440	2,021.76	2,021.76	5,348.16	3,100.00				
		Exhaust Blower(S)	1	7.7	0.12	3,326.40	3,326.40						
2	Mid AC	Supply Blower	6	0.60	0.0667	144.07	7,217.06	7,217.06	6,600.00	29.5	22	26.6	49
				3.80	0.1219	1,667.59							
				4.20	0.1350	2,041.20							
				5.30	0.1350	2,575.80							
				4.70	0.0300	507.60							
				2.60	0.0300	280.80							
		Exhaust Blower	1	5.30	0.3500	6,600	6,600	6,600	6,600.00				
3	Aft AC	Supply Blower	(a) Fresh air intake trunking for supply blower removed and blanked. (b) Incomplete supply trunking at 01 location.										
		Exhaust Blower	Exhaust of the compartment not working view sluice valve stuck at closed position.										

4	Shaft Alleyway(S)	Supply Blower	(a) Fresh air intake trunking for supply blower removed and blanked. (b) Incomplete supply trunking at 01 location.											
		Exhaust Blower	Exhaust of the compartment could not be checked view SOQC Valve in Stbd Hangar stuck in closed position.											
5	Shaft Alleyway(P)	Supply Blower	Fresh air intake trunking for supply blower removed and blanked.											
		Exhaust Blower	Exhaust of the compartment could not be checked view SOQC Valve in Stbd Hangar stuck in closed position.											
6	Refrigeration compartment	Supply Blower	1	1.60	0.0080	46.08	46.08	46.08	525.00	32	25	29.7	55	
		Exhaust Blower	Exhaust Blower Non Ops											

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NATAA/318/H

21 Dec 21

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MACHINERY COMPARTMENTS VENTILATION SYSTEM TRIALS

1. Refer to the following:-

   (a) NO 07/18

   (b) HITU (Mbi) letter HITU/300/39-1 dated 16 Nov 21, not addressed to all, copy enclosed.

2. HITUs are mandated to undertake Heating Ventilation & Air Conditioning (HVAC) System trials of all compartments as part of Pre and Post refit trials of ships and submarines. The ventilation system of machinery compartments has been a neglected area which has led to cascading effect on equipment and systems. It is pertinent to mention that sub-optimal machinery ventilation system severely hampers the operating conditions of the main engine and other auxiliary machinery with inappropriate ambient conditions like temperature, relative humidity, air flow, etc. Further, an improper machinery ventilation also adversely affects watch-keepers. It is important that the ventilation in these compartments are balanced and ventilation / exhaust / supply blowers are exploited as per the design and in the correct configuration. The blowers in the machinery compartments are generally of higher capacity and by exploiting them haphazardly may lead to either a vacuum / higher pressure inside the compartment. This leads to either loss of cool air from the adjacent lobbies to machinery compartments, or travel of high

temperature air to the adjacent lobbies from machinery compartments causing undesirable heat load inside the ship.

3. HITU(Mbi) has undertaken comprehensive ventilation trials of *three* machinery compartments (FER, AER and AMR) onboard INS Delhi as part of Post Refit Trials. Further, trials of the other machinery spaces are being undertaken. The detailed trials include design parameters vis-à-vis NES 102 along with impetus on system integrity checks and airflow measurement incorporating neglected areas like instrumentation, inspection windows, lagging, bellows, supporting clamps, etc. The trials report rendered by HITU(Mbi) also has brought out important observations and has recommended way ahead/ corrective actions for improvement of machinery ventilation of the ship. A copy of the report is enclosed for reference.

4. In view of the above, it is requested that Machinery Compartment Ventilation trials report prepared by HITU(Mbi) be studied and a detailed machinery compartment ventilation trials of ships and submarines under respective jurisdictions be undertaken as part of Pre and Post Refit trials of ships / submarines under NR / MR.

(Jasvir Singh)
Captain
Director
for Director General

Enclosure :- As above

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ENCLOSURE TO NATAA LETTER
NATAA|318|H dated 21 Dec 21

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HITU/300/39-01

16 Nov 21

The Commanding Officer
(for Executive Officer)
INS Delhi
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Mumbai - 400 001

VENTILATION TRIALS OF MACHINERY COMPARTMENTS-INS DELHI (MR-MLU)

1. Refer to NATAA signal DTG 151935/ Nov.

2. Ventilation trials of major machinery compartments viz. AMR, FER and AER were undertaken by HITU (Mbi) on 15 Nov 21.

3. **Guideline for trials**. Def Stan 02-102 and NES 102.

4. **Design Parameters**. The following have been considered as design parameters based on NES 102:-

(a) Ship's exploitation under following environment conditions (Hot Climates as per NES 102):-

Dry bulb Temperature	Wet Bulb Temperature
35 °C	30 °C

(b) Temperature. Main and large auxiliary machinery spaces, in 'Open Ship' condition, temperature rise above external ambient restricted to 15 °C {as per para 4.1 (d) of section 4 of NES 102}.

(c) Airflow. The exhaust should be between 107-115% of the total supply so as to account for temperature rise and dissipation of smoke, if any from the compartment {as per para 8.1.1 (c) of section 8 of NES 102}.

5. **External Environment Conditions during Trials**. The external environment parameters measured during the trials were as follows:-

Dry Bulb Temp (°C)	Wet Bulb Temp (°C)	Effective Temp(°C)	RH (%)
29	25	26.4	71

6. **Ventilation Arrangement**. The ventilation arrangement onboard in the above mentioned compartments is as follows:-

(a) FER & AER. These compartments are provided with two supply and one exhaust blowers each to be used in 'Open Ship' condition. One supply blower is fitted with a HE which is supplied with chilled water from the AC plants in a closed loop circuit for maintaining the temperature inside the compartment. The other supply blower is not fitted with any HE or sea water cooler. Moreover, one natural supply is provided to the compartment to be used in 'Open Ship' condition. This supply is provided with a sea water cooler known as the Bilge cooler.

(a) AMR. The compartment is provided with two supply and two exhaust blowers to be used in 'Open Ship' condition. No supply blower is fitted with any HE or sea water cooler.

7. **Trials**. Measurements wrt air flow of supply and exhaust blowers and temperature were recorded for each compartment. Air flow for natural supply could not be recorded for any compartment. Detailed report on the trials is placed at enclosure.

8. **Observations**. Salient observations of the trials are as following:-

(a) FER.

(i) All the blowers were operational and data was recorded wrt airflow and temperature. The effective temperature and relative humidity (RH) were calculated to be 31 °C and 38%.

(ii) Total supply and exhaust were recorded to be 4595.40 m^3/hr and 13824 m3/hr which was found to be SAT as per the criteria indicated at para 4(c) above.

(iii) 11 inspection windows were missing at various locations on the ventilation trunking.

(iv) Lagging of HE was incomplete.

(b) AER.

(i) All the blowers were operational and data was recorded wrt airflow and temperature. The effective temperature and relative humidity (RH) were calculated to be 27 °C and 65%.

(ii) Total supply and exhaust were recorded to be 18638.64 m^3/hr and 16727.04 m3/hr which was found to be UNSAT as per the criteria indicated at para 4(c) above.

(iii) Seven inspection windows were missing at various locations on the ventilation trunking.

(iv) Lagging of HE was incomplete.

(c) AMR.

(i) All the blowers except one exhaust blower were operational and data was recorded wrt airflow and temperature. The effective temperature and relative humidity (RH) were calculated to be 25.5 °C and 70%.

(ii) Total supply and exhaust were recorded to be 13458.24 m^3/hr and 2592 m3/hr which was found to be UNSAT as per the criteria indicated at para 4(c) above.

(iii) Exhaust blower (S) was found to be non-ops.

(iv) Six inspection windows were missing at various locations on the ventilation trunking.

(v) Bellows of both supply blowers and one exhaust blower were missing.

(vi) Supporting clamps of exhaust blower trunking (S) were damaged.

(vii) Two wire mesh of supply blower (S) were found to be missing.

9. **Inferences**. The following can be inferred from the trials:-

(a) Airflow.

(i) The airflow data recorded during the trials can be considered SAT for FER and UNSAT for AER and AMR view not complying with the design consideration as per NES 102 as indicated at para 4(c) above.

(ii) The trial data however cannot be compared with the design/ commissioning data view unavailability of the same.

(b) Temperature. Although the temperature recorded can be considered **SAT** in all the compartments inspected, it is pertinent to mention that the heat load of the compartments were significantly lesser than what it is expected to be while the ship is out at sea view major machinery viz. Main engines, GTGs and other auxiliary machinery not running during the trials and therefore no conclusive inference can be made from the recorded trial data.

10. **Recommendations**. In view of the above, following is recommended:-

(a) SS to project the above mentioned observations to ND(Mbi) for early liquidation.

(b) SS liaise with ND (Mbi) for early liquidation of above mentioned defects.

(c) Conduct of Ventilation trials of machinery compartments to be undertaken in conjunction with the Phase II HVAC trials at sea with full heat load disposition

so as to make meaningful assessment of ventilation system in machinery compartments.

(Nikhil Ghavate)
Lieutenant Commander
Trials Officer
for Officer-in-Charge

Encl:- As above

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Enclosure to HITU(Mbi) letter
HITU/300/39-01 dated 16 Nov 21

VENTILATION TRIALS OF MACHINERY COMPARTMENTS- INS DELHI

Ser	Compt	Blower	Ducts	Measured Values					Design Flow Rates(m3/ hr) (Commisioning Trial Document)		Temperatures & RH			
				Air Flow (m/s)	Duct Area (m^2)	Flow Rate (m3/ hr)	Total Compt. Flow Rate (m3/ hr)	Total Flow Rate (m3/ hr)	Compt	Total	DB Temp °C	WB Temp °C	Effective Temp °c	RH (%)
1	FER	Supply Blower - Axial	15	1.00	0.0090	32.40	2,676.24	4,595.40	NA	NA	39	27	31	38
				1.90	0.0090	61.56								
				2.40	0.0900	777.60								
				1.60	0.0090	51.84								
				0.30	0.0090	9.72								
				0.70	0.0900	226.80								
				1.80	0.0090	58.32								
				1.50	0.0090	48.60								
				1.80	0.0900	583.20								
				1.40	0.0900	453.60								
				0.80	0.0090	25.92								
				1.20	0.0090	38.88								
				0.80	0.0900	259.20								
				0.80	0.0090	25.92								
				0.70	0.0090	22.68								
		Supply Blower- Centrifugal	3	18.80	0.0090	609.12	1,919.16							
				3.80	0.0780	1,067.04								
				2.50	0.0270	243.00								
		Exhaust Blower	1	5.00	0.7680	13,824.0	13,824.0	13,824.0						

Ser	Compt	Blower	Ducts	Measured Values					Design Flow Rates(m3/ hr) (Commisioning Trial Document)		Temperatures & RH			
				Air Flow (m/s)	Duct Area (m^2)	Flow Rate (m3/ hr)	Total Compt. Flow Rate (m3/ hr)	Total Flow Rate (m3/ hr)	Compt	Total	DB Temp °C	WB Temp °c	Effective Temp °c	RH (%)
2	AER	Supply Blower - Axial	14	9.00	0.0400	1,296.00	1,425.60	18,638.64	NA	NA	30	25	27.0	65
				8.00	0.0400	1,152.00								
				5.50	0.0750	1,485.00								
				3.40	0.0500	612.00								
				3.00	0.0080	86.40								
				3.70	0.0080	106.56								
				4.80	0.0080	138.24								
				5.50	0.0080	158.40								
				2.50	0.0080	72.00								
				4.50	0.0080	129.60								
				7.50	0.0900	2,430.00								
				4.60	0.0900	1,490.40								
				0.30	0.0080	8.64								
				0.40	0.0900	129.60								
		Supply Blower-Centrifugal	4	1.50	0.0900	486.00	17,213.04							
				2.10	0.0300	226.80								
				7.70	0.0300	831.60								
				1.20	0.0300	129.60								
		Exhaust Blower	1	6.60	0.7040	16,727.04	16,727.04	16,727.04						
3	AMR	Supply Blower(P)	5	1.60	0.1200	691.20	5,843.16	13,458.24	NA	NA	28	24	25.5	70
				6.50	0.0170	397.80								
				4.50	0.1200	1,944.00								
				7.80	0.0170	477.36								
				5.40	0.1200	2,332.80								
		Supply Blower (S)	7	7.10	0.1200	3,067.20	7,615.08							
				7.20	0.0170	440.64								
				13.00	0.0170	795.60								
				6.50	0.0450	1,053.00								
				17.00	0.0170	1,040.40								
				6.60	0.0240	570.24								
				1.50	0.1200	648.00								

Ser	Compt	Blower	Ducts	Measured Values					Design Flow Rates(m3/ hr) (Commisioning Trial Document)		Temperatures & RH			
				Air Flow (m/s)	Duct Area (m^2)	Flow Rate (m3/ hr)	Total Compt. Flow Rate (m3/ hr)	Total Flow Rate (m3/ hr)	Compt	Total	DB Temp ^oC	WB Temp ^oc	Effective Temp ^oc	RH (%)
3	AMR	Exhaust Blower (P&S)	1	6.00	0.1200	2,592.00	2,592.00	2,592.00	NA	NA	28	24	25.5	70