

Draft Note on

Logistics of Material Movement, India-based Neutrino Observatory (INO)

1 Background

A meeting convened on behalf of Dr. Anil Kakodkar, Chairman, Atomic Energy Commission and attended by Dr. C.K. Sreedharan, the Principle Chief Conservator of Forests, Tamil Nadu and the officials of the Forest Department, was held at the Institute of Mathematical Sciences on 18th December 2008. The issue of construction and detector material movement, more particularly the impact of movement of vehicles along the Singara-Masinagudi road on wildlife, was raised, especially as the road cuts across an important elephant movement corridor.

EMP Recommendation : The Environmental Management Plan (EMP), prepared by Care Earth for INO, places severe restrictions on the movement of vehicles on the Masinagudi–Singara road, based on studies of the current traffic pattern in the region. It recommends a complete cessation on movement of heavy vehicles during the main elephant migration period (which falls during approximately 3 months from November to February). Furthermore, it recommends that heavy vehicular movement be restricted to day-light hours, in particular, between 6.00 AM and 4.00 PM at any time of the year, in order to avoid the dawn/dusk large-animal movement and the night hours when the night-animals are abroad.

Compliance : The compliance report prepared in response to the EMP by INO restricts the number of round trips to 6 per day during the times and months stipulated in the EMP, where each round trip may consist of a single truck or a single convoy consisting of maximum three trucks. Note that the maximum load carrying capacity of a truck in the region is limited to 8 tons.

Organisation of the report : This report gives details on the following:

- The material types, quantities and their transportation to the site at Singara,
- The muck generation from the excavation of the tunnel and cavern; its storage, usage and transportation out of Singara.

The following tables and the accompanying graphs show that the project can be completed within the time span as projected in the Detailed Project Report (DPR), complying with the above restrictions by suitably planning and phasing the movement of materials.

2 Note on the quantity of material

2.1 Construction material and equipment

This includes all the material that is to be brought in to the site.

1. One-time movement of construction equipment such as drill jumbos, mobile crane, tipper trucks, jack hammers, rock bolters, excavators/loaders, etc.
2. About 12,000 tons of cement and 3,500 tons of sand for construction.
3. About 4,000 tons of structural steel and utility equipment.
4. About 53,000 tons of iron, glass RPC detectors and other detector material for neutrino ICAL detector. Of this, 1/3 will be moved in the 4th year of construction to build the first module of the detector. The second and third modules will be built over the next few years.

2.2 Tunnel/cavern excavated granite muck

The tunnel muck generated will be 2,25,000 cubic meters. The muck to be utilised will be about 25,480 cubic meters (61,150 tons) for project construction. The muck will be stored in the TNEB muck yard, for eventual evacuation.

The balance muck will require about 16.6 years from the date of commencement of project or about 9.5 years from the completion of the second phase of the INO project (covering the installation of the last two 2 modules of the ICAL detector) to be moved out of the site.

3 Abstract of material movement

We first give the year-wise abstract of total material movement and the number of trips required. Detailed break-up of all the materials and their movement logistics is given subsequently.

Note that the following realistic assumptions have been made in working out the details of the material transportation:

- Material will be brought in and muck moved out in separate trucks.
- Assumed maximum load capacity of 8 tons per truck.
- Assumed unit trip for transportation of steel plates as a convoy of 3 numbers of 8 ton trucks, that is 2×4 ton plates per truck.
- Assumed unit trip for transportation of rock muck as a convoy of 3 numbers of 8 ton trucks.
- Assumed 6 tons per truck for sand transportation.
- Assumed unit trip for transportation of all other materials as a single truck of 8 ton capacity.
- In-situ long term storage of rock muck at the storage yard can be planned.

Year	Q-I (16 Feb to 15 May)		Q-II (16 May to 15 Aug)		Q-III (16 Aug to 15 Nov)		Average round trips per day			
	No. Trips In	No. Trips Out	No. Trips In	No. Trips Out	No. Trips In	No. Trips Out	Q-I	Q-II	Q-III	Q-IV
1	47	47	176	176	432	432	0.52	1.96	4.80	0
2	342	342	342	342	536	536	3.80	3.80	5.96	0
3	538	538	540	540	540	540	5.98	6.00	6.00	0
4	491	491	530	530	538	538	5.46	5.89	5.98	0
5	530	530	530	530	530	530	5.89	5.89	5.89	0
6	528	528	540	540	538	538	5.87	6.00	5.98	0
7	539	539	531	531	534	534	5.99	5.90	5.93	0
8-16.6 years	530	530	530	530	530	530	5.89	5.89	5.89	0

Table 1: Year-wise abstract of the average number of round trips per day over three quarters of the year are given. Years 8–16.6 involve only the rock muck movement as the laboratory would be complete and operating by then.

Ser. no.	Materials	Quarter 1 (16 Feb to 15 May)				Quarter 2 (16 May to 15 Aug)				Quarter 3 (16 Aug to 15 Nov)				Quarter 4 (16 Nov to 15 Feb)			
		IN Quantity (tons)	No. trips	OUT Quantity (tons)	No. trips	IN Quantity (tons)	No. trips	OUT Quantity (tons)	No. trips	IN Quantity (tons)	No. trips	OUT Quantity (tons)	No. trips	IN Quantity (tons)	No. trips	OUT Quantity (tons)	No. trips
YEAR 1																	
1	Cement	16	2		2	160	20		20	288	36		36				
2	Reinforcement Steel					160	20		20	160	20		20				
3	Sand	18	3		3	108	18		18	240	40		40				
4	Muck /metal																
5	Steel/GI (utilities)		4		4		100	2400	100				7200	300			
6	Electrical Equipment																
	i. Transformers		1		1												
	ii. Cables		1		1												
	iv. Panels																
	v. Others		3		3		3		3				6				
7	AC/Vent equipment																
	i. AC chillers																
	ii. Blowers																
	iii. Cooling towers																
	iv. Air compressors		3		3												
	v. Others		30		30		15		15				30				
8	Muck utilisation at site																
	i. Tunnel lining												1100				1200
	ii. Caverns																
	iii. Surface facilities																
9	Detector materials																
	i. Steel																
	ii. RPC																
	iii. Magnet coil (Cu)																
	iii. Others																
	Total no. of Trips		47		47		176		176		432		432				432
	Average trips per day betw. Singara and Masinagudi		0.52		0.52		1.96		1.96		4.80		4.80				4.80

Ser. no.	Materials	Quarter 1 (16 Feb to 15 May)				Quarter 2 (16 May to 15 Aug)				Quarter 3 (16 Aug to 15 Nov)				Quarter 4 (16 Nov to 15 Feb)			
		IN		OUT		IN		OUT		IN		OUT		IN		OUT	
		Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips
YEAR 2																	
1	Cement	160	20		20	160	20		20	320	40		40				
2	Reinforcement Steel	64	8		8	64	8		8	528	66		66				
3	Sand	54	9		9	54	9		9	240	40		40				
4	Muck /metal		300	7200	300		300	7200	300		380	9120	380				
5	Steel/GI (utilities)																
6	Electrical Equipment																
	i. Transformers																
	ii. Cables																
	iv. Panels																
	v. Others																
7	AC/Vent equipment																
	i. AC chillers																
	ii. Blowers.																
	iii. Cooling towers																
	iv. Air compressors																
	v. Others		5		5		5		5		10		10				
8	Muck utilisation at site																
	i. Tunnel lining			800				800				550			550		
	ii. Caverns																
	iii. Surface facilities																
9	Detector materials																
	i. Steel																
	ii. RPC																
	iii. Magnet coil (Cu)																
	iii. Others																
	Total no. of Trips		342		342		342		342		536		536		0		0
	Average trips per day betw. Singara and Masinagudi		3.80		3.80		3.80		3.80		5.96		5.96		0.00		0.00

Ser. no.	Materials	Quarter 1 (16 Feb to 15 May)				Quarter 2 (16 May to 15 Aug)				Quarter 3 (16 Aug to 15 Nov)				Quarter 4 (16 Nov to 15 Feb)			
		IN		OUT		IN		OUT		IN		OUT		IN		OUT	
		Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips
YEAR 3																	
1	Cement	2880	360		360	2400	300		300	2480	310		310				
2	Reinforcement Steel	720	90		90	640	80		80	640	80		80				
3	Sand	690	75		75	930	155		155	882	142		142				
4	Muck /Metal																
5	Steel/GI (utilities)		4		4		2		2		4		4				
6	Electrical Equipment																
	i. Transformers																
	ii. Cables																
	iv. Panels																
	v. Others		4		4		2		2		3		3				
7	AC/Vent equipment																
	i. AC chillers																
	ii. Blowers.																
	iii. Cooling towers																
	iv. Air compressors		3		3												
	v. Others		2		2		1		1		1		1				
8	Muck utilisation at site																
	i. Tunnel lining			4920				4920				4920		4920		4920	
	ii. Caverns			4920				4920				4920		4920		4920	
	iii. Surface facilities			1222.5				1222.5				1222.5		1222.5		1222.5	
9	Detector materials																
	i. Steel																
	ii. RPC																
	iii. Magnet coil (Cu)																
	iii. Others																
	Total no. of Trips		538		538		540		540		540		540				
	Average trips per day betw. Singara and Masinagudi		5.98		5.98		6.00		6.00		6.00		6.00				

Ser. no.	Materials	Quarter 1 (16 Feb to 15 May)				Quarter 2 (16 May to 15 Aug)				Quarter 3 (16 Aug to 15 Nov)				Quarter 4 (16 Nov to 15 Feb)			
		IN		OUT		IN		OUT		IN		OUT		IN		OUT	
		Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips
YEAR 4																	
1	Cement	3064	383		383												
2	Reinforcement Steel	408	46		46												
3	Sand																
4	Muck /Metal		20	480	20		10	240	10		125	3000	125				
5	Steel/GI (utilities)	32	4		4	400	50		50								
6	Electrical Equipment																
	i. Transformers						6		6								
	ii. Cables						2		2								
	iv. Panels						16		16								
	v. Others						6		6								
	AC/Vent equipment																
7	i. AC chillers						10		10								
	ii. Blowers						13		13								
	iii. Cooling towers						6		6								
	iv. Air compressors						1		1								
	v. Others																
8	Muck utilisation at site																
	i. Tunnel lining			4760													
	ii. Caverns			4360													
	iii. Surface facilities			2780													
9	Detector materials																
	i. Steel	720	30		30	8640	360		360	7656	319			319			
	ii. RPC					280	35		35	480	60			60			
	iii. Magnet coil (Cu)									32	4			4			
	iii. Others		8		8		15		15		30			30			
	Total no. of Trips		491		491		530		530		538			538			
	Average trips per day betw. Singara and Masinagudi		5.46		5.46		5.89		5.89		5.98			5.98			

Ser. no.	Materials	Quarter 1 (16 Feb to 15 May)		Quarter 2 (16 May to 15 Aug)		Quarter 3 (16 Aug to 15 Nov)		Quarter 4 (16 Nov to 15 Feb)	
		IN	OUT	IN	OUT	IN	OUT	IN	OUT
		Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips
YEAR 5									
1	Cement								
2	Reinforcement Steel								
3	Sand								
4	Muck /Metal	530	530	12720	530	12720	530	12720	530
5	Steel/GI (utilities)								
6	Electrical Equipment								
	i. Transformers								
	ii. Cables								
	iv. Panels								
	v. Others								
7	AC/Vent equipment								
	i. AC chillers								
	ii. Blowers.								
	iii. Cooling towers								
	iv. Air compressors								
	v. Others								
8	Muck utilisation at site								
	i. Tunnel lining								
	ii. Caverns								
	iii. Surface facilities								
9	Detector materials								
	i. Steel								
	ii. RPC								
	iii. Magnet coil (Cu)								
	iii. Others								
	Total no. of Trips	530	530	530	530	530	530	530	530
	Average trips per day betw. Singara and Masinagudi	5.89	5.89	5.89	5.89	5.89	5.89	5.89	5.89

Ser. no.	Materials	Quarter 1 (16 Feb to 15 May)				Quarter 2 (16 May to 15 Aug)				Quarter 3 (16 Aug to 15 Nov)				Quarter 4 (16 Nov to 15 Feb)			
		IN		OUT		IN		OUT		IN		OUT		IN		OUT	
		Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips
YEAR 6																	
1	Cement																
2	Reinforcement Steel																
3	Sand																
4	Muck /Metal	490	11760	490		130	3120	130		125	3000	125					
5	Steel/GI (utilities)																
6	Electrical Equipment																
	i. Transformers																
	ii. Cables																
	iv. Panels																
	v. Others																
7	AC/Vent equipment																
	i. AC chillers																
	ii. Blowers.																
	iii. Cooling towers																
	iv. Air compressors																
	v. Others																
8	Muck utilisation at site																
	i. Tunnel lining																
	ii. Caverns																
	iii. Surface facilities																
9	Detector materials																
	i. Steel	720	30	30		8640	360	360		7656	319	319					
	ii. RPC					280	35	35		480	60	60					
	iii. Magnet coil (Cu)									32	4	4					
	iii. Others							15			30	30					
	Total no. of Trips					528	540	540		538	538	538					
	Average trips per day betw. Singara and Masinagudi					5.87	6.00	6.00		5.98	5.98	5.98					

Ser. no.	Materials	Quarter 1 (16 Feb to 15 May)				Quarter 2 (16 May to 15 Aug)				Quarter 3 (16 Aug to 15 Nov)				Quarter 4 (16 Nov to 15 Feb)			
		IN		OUT		IN		OUT		IN		OUT		IN		OUT	
		Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips
YEAR 7																	
1	Cement																
2	Reinforcement Steel																
3	Sand																
4	Muck /Metal	500	12000	500		120	4800	120		120	4800	120					
5	Steel/GI (utilities)																
6	Electrical Equipment																
	i. Transformers																
	ii. Cables																
	iv. Panels																
	v. Others																
7	AC/Vent equipment																
	i. AC chillers																
	ii. Blowers.																
	iii. Cooling towers																
	iv. Air compressors																
	v. Others																
8	Muck utilisation at site	1		1		1		1		1		1		1			
	i. Tunnel lining																
	ii. Caverns																
	iii. Surface facilities																
9	Detector materials																
	i. Steel	720	30	30		8640	360	360		7656	319	319		319			
	ii. RPC					280	35	35		480	60	60		60			
	iii. Magnet coil (Cu)									32	4	4		4			
	iii. Others	8		8		15		15				30		30			
	Total no. of Trips	539		539		531		531		534		534		534			
	Average trips per day betw. Singara and Masinagudi	5.99		5.99		5.90		5.90		5.93		5.93		5.93			

Ser. no.	Materials	Quarter 1 (16 Feb to 15 May)		Quarter 2 (16 May to 15 Aug)		Quarter 3 (16 Aug to 15 Nov)		Quarter 4 (16 Nov to 15 Feb)	
		IN	OUT	IN	OUT	IN	OUT	IN	OUT
		Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips	Quantity (tons)	No. trips
YEARS 8-16									
1	Cement								
2	Reinforcement Steel								
3	Sand								
4	Muck /Metal	530	530	530	530	530	530	530	530
5	Steel/GI (utilities)								
6	Electrical Equipment								
	i. Transformers								
	ii. Cables								
	iv. Panels								
	v. Others								
7	AC/Vent equipment								
	i. AC chillers								
	ii. Blowers								
	iii. Cooling towers								
	iv. Air compressors								
	v. Others								
8	Muck utilisation at site								
	i. Tunnel lining								
	ii. Caverns								
	iii. Surface facilities								
9	Detector materials								
	i. Steel								
	ii. RPC								
	iii. Magnet coil (Cu)								
	iii. Others								
	Total no. of Trips	530	530	530	530	530	530	530	530
	Average trips per day betw. Singara and Masinagudi	5.89	5.89	5.89	5.89	5.89	5.89	5.89	5.89