

शिव अभिलाष भारद्वाज, एफएनएई
S. A. BHARDWAJ FNAE

अध्यक्ष
CHAIRMAN

No. CH/AERB/GHAVP-1&2/2018/06

January 17, 2018

Excavation Consent for GHAVP-1 & 2

References:

- 1) No.CH/AERB/GHAVP-1 to 4/199/2015/2336 dated 8th July 2015
- 2) No. NPCIL/Engg/RI/00011/M/2014/33 dated 11th June 2014
- 3) No NPCIL/GHAVP/PD/2017/32 dated 13th September 2017


Consent Number	GHAVP-1&2/2/1/00/00
Stage of Consent	Site Excavation
Consent issued by	Chairman, AERB Competent Authority to enforce safety related rules issued under Atomic Energy Act, 1962
Applicant	Nuclear Power Corporation of India Ltd (NPCIL)
Brief Description of Nuclear Power Project	NPCIL proposes to set up four units of 700 MWe PHWRs (GHAVP-1 to 4) at Gorakhpur, Haryana. Siting consent for GHAVP-1 to 4 was issued by AERB in July 2015 [1]. Application for excavation consent of two units (GHAVP-1&2) was submitted initially in June 2014 [2] and the application was revised in September 2017 ([3].
Basis of issuing the Consent	AERB regulatory requirements as per AERB Safety Codes on (i) Design of Pressurized Heavy Water Reactor Based Nuclear Power Plants, AERB/NPP-PHWR/SC/D (Rev.1) (ii) Site Evaluation of Nuclear Facilities, AERB/SC/S (Rev.1) (iii) Quality Assurance in Nuclear Power Plants, AERB/NPP/SC/QA (Rev.1) (iv) Regulation of Nuclear and Radiation Facilities, AERB/SC/G Safety Guide on Consenting process for Nuclear Power Plants & Research Reactors (AERB/ NPP&RR/ SG/ G-1), and related AERB Safety Standards and Guides.
Safety Review	AERB conducted safety review and assessment of NPCIL's application for excavation consent of GHAVP-1&2 following its established consenting process to check completeness of the

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	<p>data/information required with respect to the excavation consent stage and compliance to the corresponding design safety and QA requirements specified in applicable regulatory safety documents. The documents submitted in support of the application for excavation consent included some information/data relevant to subsequent consenting stages, which was also reviewed. These are briefly described in Annexure-1.</p> <p>The proposed activities of excavation can be carried out in compliance of this consent without undue risk to workers, the public and the environment.</p>
Responsibility of Safety	<p>The applicant is responsible for safety associated with the consented activities and/or facilities.</p> <p>It is also the responsibility of applicant to comply with safety requirements specified in regulations.</p>
Other statutory requirements	<p>Status of compliance to MoEFCC stipulations by the applicant as relevant to AERB is brought in Annexure-1.</p> <p>The applicant shall ensure that all necessary statutory clearances are obtained and are valid for present stage of consent i.e. excavation.</p>

Based on satisfactory review as brought out above, consent is hereby granted for Site Excavation of GHAVP-1&2. Stipulations and conditions arising out of the review carried out so far are brought out in Annexure-2. Compliance to these stipulations and conditions shall be ensured for applicable consenting stages.

This consent is valid till January 31, 2020. The excavation activity of safety and safety related structures as per AERB/NPP&RR/SG/G-1 shall be completed within the validity period, else extension shall be sought with justification.


(S.A. Bhardwaj) 17.1.18

End. Annexures-1 &2

**Chairman and Managing Director
Nuclear Power Corporation of India Ltd.
Nabhikiya Urja Bhavan (NUB)
Anushaktinagar
Mumbai - 400 094.**

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SAFETY REVIEW OF GHAVP-1&2 FOR EXCATION CONSENT

1. Safety Review

Nuclear Power Corporation of India Limited (NPCIL) proposes to set up 4 units of 700 MWe PHWR based Nuclear Power Plants (NPP) at Gorakhpur in Haryana state. Siting consent for GHAVP-1 to 4 was granted in July 2015. As per the current practice for NPP, a single consent can be granted for construction or it can be granted in three sub stages, namely – foundation excavation, first pour of concrete (FPC) and major equipment erection (MEE). Construction consent in a single stage or in sub stages is granted by AERB on the basis of in-house review followed by further deliberation of safety related items and issues in multi-tier safety committees as per the established consenting process in AERB.

Application for excavation consent of GHAVP-1&2 was submitted by NPCIL in June 2014. Subsequently, a revised application was submitted in September 2017. NPCIL progressively submitted documents in support of the application for excavation consent between 2014 and 2017. Broad subject areas of review included the following:

- a) PSAR Section-1 on General Description of Plant: Safety and Seismic Classification
- b) PSAR Section-2 on Siting and Environmental Data
- c) PSAR Section-3 on Building and Structures
- d) Status of compliance to stipulations made by AERB during siting consent
- e) Quality Assurance Manual for Design and Site Construction
- f) Design basis reports and design reports for items important to safety
- g) Plant layout and site grading
- h) Report on design basis ground motion parameters, geo-technical investigations and foundation parameters, meteorological parameters
- i) Design basis reports (including dynamic analysis methodology) of civil engineering structures/buildings important to safety
- j) Excavation schedule, drawings and procedures
- k) Industrial and fire safety

2. Compliance to Regulatory Requirements for Excavation

The review was conducted to check completeness of the data/ information required with respect to the excavation consent stage and compliance to the corresponding design safety and QA requirements specified in applicable regulatory safety documents. Lessons learned during review of earlier 700 MWe projects of similar design (KAPP-3&4 and RAPP-7&8) were kept in view during the safety review process. Review was focused more on aspects that are different from those in KAPP 3&4/RAPP 7&8 because of site specific conditions. The documents submitted in support of the application for excavation consent included some information/data relevant to subsequent consenting stages, which was also reviewed. Compliance with the requirements of AERB/NPP&RR/SG/G-1 for excavation stage/sub-stage of GHAVP-1&2 and stipulations and conditions arising out of the review carried out so far are given below:

2.1 Review of Relevant Safety Analysis Reports (Preliminary): Parts of preliminary safety analysis report (PSAR) chapters 1 to 3 were reviewed to ascertain completeness of data/information required with respect to excavation consent as per AERB/NPP&RR/SG/G-1. The review was focused more on design differences with respect to already reviewed 700MWePHWRs in recent past, compliance to AERB safety code on Design of PHWRs (AERB/NPP-PHWR/SC/D, Rev.1), safety assessment of site specific hazards considering AERB safety code AERB/SC/S rev.1 (e.g. Extreme value analysis of meteorological parameters, design basis flood level and safe grade elevation, design basis geotechnical parameters, design basis ground motion), safety review of related engineering measures and safety assessment of newly introduced foundation system viz. Combined Pile Raft Foundation (CPRF) system. Review also covered bulk shielding, penetration shielding, and layout of rooms containing radioactive sources.

2.2 Review of Foundation System: Major design related changes (from KAPP-3&4 and RAPP-7&8) for GHAVP pertains to consideration of Soil-Structure Interaction (SSI) and increased isolation gap to cater to expected higher lateral displacement for soil sites.

Considering the alluvial type founding strata, combined pile-raft foundation (CPRF) system is proposed for safety related structures.

During safety review it is noted that despite having access to the site, NPCIL could not generate any site specific information on pile behavior. Case histories of pile construction in alluvium shows that several issues could arise during course of construction of piles. NPCIL was cautioned early during AERB review of the proposed CPRF regarding possible implications of non-availability of site specific test data vis-à-vis latter activities of construction of proposed CPRF and related test data.

A preliminary SSI analysis was undertaken for vertical and horizontal load, where entire nuclear building raft, pile layout and superstructure were modeled numerically and interaction effects were studied. Review was conducted following International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE) guidelines for CPRF and related AERB/BIS requirements for piles. The review related submissions and recommendations covered following broad areas: 1) Behavior of combined piled-raft system, 2) Validation/ verification of the proposed soil structure interaction methodology, 3) Static analysis methodology, 4) Dynamic analysis methodology, 5) Pile construction and quality control aspects, and 6) Proof checking and independent verification of analysis and design.

In view of non-availability of site specific pile test data, a structured review plan in the form of regulatory hold points has been chalked out to address various safety review aspects emanating out of CPRF including those related to pile behavior, testing and construction, which is to be considered during detailed review stage before consent for first pour of concrete.

2.3 Design Basis Ground Motion (DBGM) Parameters: Design Basis Report on DBGM presented seismotectonic study as specified in AERB regulatory documents. Details of field investigations were also provided. Site response analysis was conducted to arrive at free field ground motion parameters after accounting for the effects of thick alluvial deposit below foundation, which alters the ground motion parameters of base rock. For the first time, probabilistic seismic hazard analysis (PSHA) was also conducted by NPCIL for estimating the DBGM parameters. DBGM parameters derived from these

studies were found acceptable.

- 2.4 Liquefaction Hazard Assessment (LHA) and Ground Improvement (GI):** NPCIL report on liquefaction hazard assessment was reviewed and accepted based on acceptance criteria developed by AERB taking into account related USNRC requirements. To eliminate liquefaction at GHAVP site, ground improvement technique is proposed. After various mock-up studies, proposal of soil-cement mix with 5% cement compacted in layers was accepted as ground improvement methodology. The soil-cement mix was also verified to meet acceptance criteria of relevant special Publication of Indian Road Congress (IRC).
- 2.5 Bulk Shielding:** utility proposed that the Bulk Shielding of GHAVP-1&2 is broadly the same as that for KAPP-3&4 and RAPP-7&8, except for some changes, mainly pertaining to larger seismic gap from inner containment wall (ICW) at Pump Room, Moderator Room and Spent Fuel Discharge Port (SFDP). Bulk shielding of GHAVP-1&2 with respect to Excavation Clearance stage is acceptable. Other detailed shielding aspects for GHAVP-1&2 would be progressively reviewed during subsequent consenting stages.
- 2.6 Excavation Procedure and Dewatering Scheme:** The excavation procedure and excavation drawings for main plant buildings & structures and dewatering scheme submitted for review, was generic in nature. Final excavation procedure will be prepared by the contractor, once the work is awarded. Considering this, AERB has stipulated that detailed site specific excavation procedure, along with documents related to dewatering scheme, slope stability, construction QA manual, JHA, construction methodology etc. should be submitted and review of the same should be completed before commencing actual excavation at site.
- 2.7 Industrial and Fire Safety:** Construction Safety Management Manual, Job Hazard Analysis and Safe Working Procedures (sample basis), provisions for emergency escape from Cable Tunnels & Trenches, GA drawings of various buildings and other supporting documents for industrial safety during construction (mainly site excavation

stage) have been reviewed. Compliance to Atomic Energy Factory Rules-1996 (AEFR-1996) of various safety related buildings are also reviewed.

2.8 Nuclear Security: CRSANF of AERB reviewed nuclear security aspects for GHAVP-1&2 and ascertained compliance to the related requirements for excavation consent stage.

3.0 Compliance to MoEF & CC stipulations relevant to AERB by Applicant

The Ministry of Environment & Forests and Climate Change (MoEF & CC) had issued Environmental Clearance for GHAVP 1-4 on 27th December 2013. In the Environmental Clearance Letter issued for GHAVP, for certain stipulations AERB is referred (item 6A, specific conditions). With respect to excavation consent, the status of compliance to MoEF & CC stipulations for GHAVP by Applicant as relevant to AERB are brought out below:

3.1 AERB clearance for Site shall be obtained before starting any construction work and a copy of same shall be provided to MoEF & CC

Compliance Status: AERB issued Siting Consent for GHAVP units 1-4 vide No.CH/AERB/GHAVP-1 to 4/199/2015/2336 dated July 8 2015. It is noted that NPCIL has been submitting half yearly compliance status reports to MOEF&CC after Siting consent. AERB is now granting excavation clearance after satisfactory review.

3.2 Regular monitoring of conventional gaseous pollutants, radioactive pollutant in the air as well as in the discharged water shall be monitored regularly as per AERB Standards.

Compliance Status: NPCIL has submitted that requirement of regular monitoring of pollutants will arise after criticality of unit and will be complied. The same will be followed up by AERB during commissioning and operation of NPP (as per Tech. specs)

3.3 The non-radioactive wastewater generated from the plant premises shall be

suitably treated in sewage treatment plant (STP) and the treated effluent shall be recycled and reused within the plant premises for greenbelt etc. The radioactive liquid waste emanating from the plant shall be treated and managed as per guideline of AERB/ICRP in this regard.

Compliance Status: NPCIL has stated that requirement of Treatment/management of the radioactive liquid waste emanating from the plant will arise after criticality of unit and will be complied. The stipulation will be followed up by AERB during further consenting stages viz. related to detailed design review, commissioning and operation stage.

- 3.4 The radioactive levels in the different matrices of environment including food chain, air water and soil shall be monitored regularly in the surrounding areas as per AERB standards and records maintained. The conventional pollutant shall also be monitored and record maintained.**

Compliance Status: NPCIL has committed that requirement of regular monitoring of radioactive levels in the different matrices of environment & conventional pollutants will start after establishment of ESL at Colony. The same is not a hold condition with respect to excavation consent.

- 3.5 The radioactive waste shall be managed as per the norms prescribed by AERB.**

Compliance Status: NPCIL has submitted that requirement of management of radioactive wastes will arise after criticality of unit and will be complied. The same is not a hold condition with respect to excavation consent and will be followed up by AERB during detailed design review stage.

- 3.6 The radioactive dose apportionment from each unit shall be as per the limits prescribed by AERB.**

Compliance Status: NPCIL has stated that apportionment of radioactive dose from each unit shall be ensured as per the limits before Initial fuel loading into the reactor

and will be complied. AERB has reviewed the related submission made by NPCIL and accepted the same.

- 3.7 Radioactive solid waste shall be collected, segregated, treated at source and disposed off with the application of advance technology as per AERB guideline in Near Surface Disposal Facility (NSDF) which shall be fenced and dose rate shall not exceed 0.01mGy/h. Spent fuel removed from the reactor shall be stored in spent fuel storage bay (SFSB) till it cools down to dry storage level (about 5 years) and shall be disposed as per the guidelines and procedures prescribed by the AERB in this regards.**

Compliance Status: NPCIL has stated that requirement of management of radioactive solid wastes will arise after criticality of unit and will be complied. The same is not a hold condition with respect to excavation consent and will be evaluated by AERB during further consenting stages.

- 3.8 A Disaster Management Plan and Emergency Preparedness Plan shall be prepared and put up in place as per the norms of AERB. Regular Mock drill shall be undertaken and based on the same, any modification required, if any, shall also be incorporated.**

Compliance Status: NPCIL has stated that Disaster Management Plan and Emergency Preparedness Plan shall be prepared before Initial fuel loading into the reactor and will be complied. AERB has completed review of feasibility aspects of Emergency Preparedness Plan and final plan will be reviewed by AERB before initial fuel loading (IFL).

- 3.9 Periodic health survey of the population residing within 5 Km around the proposed plant site shall be undertaken and the report of the survey shall be submitted to the AERB and to the Ministry of Environment & Forest and its regional office at Chandigarh.**

Compliance Status: NPCIL has reported that process for health survey of the population has been started and is in progress.

AERB Stipulations and Conditions

- 1) Considering the site-specific conditions, implementation of ground improvement measures for foundation soil stability and adoption of combined pile raft foundation (CPRF) structural system for foundations of building structures of GHAVP-1&2, regulatory hold points (RHP) have been identified for detailed safety review of design and construction related aspects. These RHP are related to timeline of submittals from NPCIL considering their proposed project schedule and are linked to the review time required following excavation consent (EC) until consent for first pour of concrete (FPC). The time line and RHP are provided in Table-1.

NPCIL shall comply with and submit all details as per Table-1 for review by AERB. These submittals shall address all engineering and QA aspects and related acceptance criteria as described in the review reports for GHAVP-1&2.

- 2) NPCIL shall perform liquefaction hazard assessment of entire plant site for GHAVP-1&2 using approved methodology and acceptance criteria, utilizing data from all the boreholes for the approved design basis and beyond design basis ground motion parameters, before commencement of excavation for foundations. Based on this assessment, NPCIL shall implement ground improvement to mitigate the liquefaction hazard as per the approved methodology and establish its adequacy using approved acceptance criteria (see also Table-1).
- 3) Detailed SSI analysis in line with the requirements specified in USNRC SRP 3.7.2 shall be performed and reviewed before first pour of concrete, following timelines indicated in Table-1. The final decision on acceptability of the design will be taken after the results of detailed SSI analysis are available and satisfactorily reviewed.
- 4) Details of schedule of drain construction, requirement of additional pumps, draining arrangements even during extreme events, maintenance of dewatering system, related security aspects, etc. are required to be reviewed in detail. NPCIL should furnish necessary details to facilitate review before issue of consent for FPC.
- 5) Lessons learnt from each phase of pile construction and tests should be documented and incorporated into the corresponding procedures before actual pile construction and testing for safety related structures. Methodology and QA/QC plans/procedures for pile construction, pile load testing & nondestructive testing (NDT) shall be submitted for review before issue of consent for FPC.

- 6) The following stipulations shall always be adhered to:
- Safety requirements of the Atomic Energy (Factories) Rules 1996 and relevant AERB Directives/Notifications,
 - Effective implementation of adequate QA to ensure compliance to AERB Safety Code on Quality Assurance in NPPs (AERB/SC/QA (2009)),
 - Significant event or change should be reported as per ECRP guidelines.

TABLE-1

Timeline and Regulatory Hold Points (RHP) for GHAVP-1&2

Sl. No.	Activity	Target date as RHP
[1]	(i) Submission and review of BDBE parameters. (ii) Finalization of depth of Ground Improvement based on approved DBGM & BDBE parameters	<i>To be submitted & reviewed at the earliest, but not later than T0+1 Month</i>
[2]	Satisfactory review of submissions related to excavation including that from contractor e.g. revised excavation plan including GI, excavation procedure, JHA and Dewatering Procedure and QA program for excavation (excluding GI)	<i>T0+1 month but before start of actual excavation</i>
[3]	Safety review & Finalization of i) validation test Pile matrix and ii) Initial Test Pile matrix	<i>T0+1 month but before start of actual excavation</i>
[4]	Finalization of detailed note on long term and short term instrumentation and monitoring of structure, pile, soil etc. including that for test piles	<i>T0+1 month but before start of actual excavation</i>
[5]	Submission of procedure for validation pile construction (at Existing ground level) and its testing methodology	<i>T0+1 month but before start of actual excavation</i>
[6]	Submission and finalization of plan for Confirmatory geotechnical investigation taking into account ground improvement, as applicable	<i>T0+1 month but before start of actual excavation</i>
[7]	Submission & satisfactory review of report on numerical prediction of P-y curves and parameters at instrumented locations of validation piles using specific soil properties from proposed test pile location including bore log data up to at least pile length + 5m.	<i>To be submitted for review at the earliest, & before T_{FPC}-9 months</i>
[8]	Sensitivity analysis : identification of model parameters for which	<i>February 28, 2018 &</i>

	sensitivity analysis is to be conducted for safety related structures under: a. Static load b. Dynamic load	<i>before T_{FPC}-8 months</i>
[9]	Resolution of issues related to transfer of information between two numerical models used by NPCIL for analysis of CPRF (ABAQUS & NISA)	<i>February 28, 2018 & before T_{FPC}-8 months</i>
[10]	(i) Resolution of issues related to modeling NB Raft considering 3D Solid finite elements vs. 2D Shell finite elements (ii) Resolution of issues related to extent of model in horizontal and vertical direction	<i>February 28, 2018 & before T_{FPC}-8 months</i>
[11]	Resolution of issues related to Effect of adjacent buildings.	<i>February 28, 2018 & before T_{FPC}-8 months</i>
[12]	User validation of SASSI	<i>February 28, 2018 & before T_{FPC}-8 months</i>
[13]	Submission of report on input parameters for dynamic analysis in SASSI and proposed soil profile including best estimate, lower & upper bound soil profiles to be used in SASSI	<i>February 28, 2018 & before T_{FPC}-8 months</i>
[14]	Submission of report on modeling and design approach for shrinkage (Typical Calculation)	<i>February 28, 2018 & before T_{FPC}-8 months</i>
[15]	QA program for ground improvement by contractor also addressing additional ITP and confirmatory tests	<i>February 28, 2018 & before T_{FPC}-8 months</i>
[16]	Aspects related to Dynamic analysis: a) Comparison of dynamic analysis results for a typical building using proposed approach in ABAQUS with analysis in SASSI. b) Resolution of aspects related to Time history analysis for dynamic SSI Vis-à-vis SRP requirements	<i>March 31, 2018 & before T_{FPC}-7 months</i>
[17]	Validation of pile-group action by numerical simulation	<i>April 30, 2018 but & before T_{FPC}-6 months</i>

[18]	<p>Submissions required before start of review of analysis report:</p> <ul style="list-style-type: none"> a) Completion of review of items #1 to #17 above b) Submission of report on test results of validation piles and proposal for calibration/modification, if required & outcome of repeat test, if necessary c) Finalization and submission of soil and interface properties to be used in numerical analysis for all safety related buildings d) Revised capacity estimation of actual piles, if required. e) Numerical prediction of P-y curves and parameters at instrumented locations of test piles using specific soil properties from proposed test pile location including bore log data up to at least pile length + 5m. 	<p><i>April 30, 2018, but not later than T_{FPC}-6 months</i></p>
[19]	<p>Submission of report of SASSI analysis of NB</p>	<p><i>July 31, 2018 but not later than T_{FPC} - 3months</i></p>
[20]	<p>Progressive submission of :</p> <ul style="list-style-type: none"> a. DBRs (if applicable) & Seismic Analysis Reports (SAR) of all safety related buildings b. Design Reports (DR) of NBs, CB & SABs. c. Proof checking reports and independent design check reports 	<ul style="list-style-type: none"> a. <i>DBR & SAR: 2 months before corresponding DR</i> b. <i>DRs : July 31, 2018 but not later than T_{FPC} - 3months for the corresponding building</i> c. <i>With corresponding time lines of a & b above</i>
[21]	<p>Outcome of tests on Ground Improvement & confirmatory investigation</p>	<p><i>July 31, 2018 but not later than T_{FPC} - 3months for the corresponding building</i></p>
[22]	<p>Civil construction and QA related documents including contractor's documents (as per AERB/SG/G-1).</p>	<p><i>August 31, 2018 but not later than T_{FPC} - 2months</i></p>
[23]	<p>The test results from Initial Test Piles of corresponding units / structures (Initial Test Pile results from NB1 & NB2 should be submitted together)</p>	<p><i>September 30, 2018 but not later than T_{FPC} - 1month for the</i></p>

		<i>corresponding building</i>
[24]	Resolution of other issues identified during review by AERB : as per appropriate time line	<i>As per mutually agreed timeline on case by case basis.</i>

Note:

T0 : Date of consent for excavation by AERB

T_{FPC} : Expected date of **NPSD** recommendation for FPC consent

