

**IRUP**

**STANDARD CONSTRUCTION SPECIFICATION  
FOR**

**GROUTING WORK**

**DOC. NO. : G-304**

**PROJECT NAME :  
RESIDUE UPGRADATION AND MS/HSD QUALITY IMPROVEMENT  
PROJECT**

**UNIT NAME :GT-HRSG**

**JOB NO. : 6235**


**CLIENT:  
INDIAN OIL CORPORATION LIMITED  
GUJARAT REFINERY,VADODARA,INDIA**

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**CONSTRUCTION AND PLANNING DEPT**




**TOYO ENGINEERING INDIA LIMITED  
MUMBAI, INDIA**

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## 1.0 SCOPE

- 1.1 The work covered by this specification consists of furnishing all equipment, materials, labour and performing all operations required for installation of grouts for steel column base-plates and/or bearing plates, anchors for equipment foundations and pockets at locations shown on the drawings for GT-HRSG Unit at IOCL's Gujarat Refinery in Vadodara, Toyo Engineering India Ltd has been appointed by Indian Oil Corporation Limited (IOCL), as "Project Management Consultant " (PMC).

## 2.0 REFERENCE DOCUMENTS

The work shall be in compliance with all application governmental and local laws, regulations and standards, as well as the following :


IS 269-1976	Ordinary and low heat Portland cement
IS 456-1978	Code of practice for plain and reinforcement concrete
ASTM C 109-80	Standard test method for compressive strength of hydraulic cement mortars
ASTM C 531	Standard test method for Linear Shrinkage and co-efficient of Thermal expansion of Chemical resistant mortars, grouts and monolithic surfacings
ASTM C 579-75	Standard test method for compressive of chemical resistant mortars and monolithic surfacings
ASTM C 230	Specification for Flow Table in Tests of Hydraulic Cement.
ASTM C 827	Standard Test Method for the Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures
ASTM C 1090	Test Method for Measuring Change in Height of Cylindrical Specimens from Hydraulic-Cement Grout
ASTM C 1107	Standard Specification for packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C 1181	Standard Test Method for Compressive creep of Chemical-Resistant Polymer machinery grouts

### PMC's Work Item Description

MC-02D	Grouting (Anchor Bolt Pockets & Equipment Bases)
MC-02E	Grouting below Structural Steel Column Bases & Roof Trusses
MC-02F	Grouting of Anchor Bolt below Equipment Foundation Base Plates with No shrink free flow Grout Mix

## 3.0 MATERIAL

- 3.1 Sand cement dry pack shall be proportioned at the site, but all non-shrink grouts shall consist of only pre-measured, prepackaged materials supplied by the grout manufacturer, except water.

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3.2 Non-shrink Epoxy grout shall be 100% solids, premeasured, prepackaged system containing thermo-setting epoxy resins and inert fillers.

3.3 Water shall be clean, portable and free from all deleterious materials such as oils, alkalis and organic materials.

#### **4.0 DELIVERY, STORAGE AND HANDLING**

4.1 All material shall be delivered to the jobsite in original, unopened packages, clearly labeled with the manufacturer's identification and printed instructions. Contractor shall be responsible for storing and handling all cementitious materials in accordance with the recommendation of the manufacturer or it shall be stored in a dry, weatherproof area and within a temperature range of 4<sup>0</sup>C to 32<sup>0</sup>C.

4.2 Any material which becomes damp or otherwise defective shall be immediately removed from the site by contractor at his own expense.

#### **5.0 REQUIREMENTS**

5.1 The location and extent of any grouting is shown or noted on the drawings.

5.2 All conflicts between the requirements of this specification and related specifications, standards, codes or drawings or equipment or grout manufacturer's recommendations shall be referred to purchaser's Engineer-in-charge for clarification and resolution.

5.3 Where equipment manufacturer's drawings define a grouting procedure, said procedure shall be followed, subject to the approval of purchaser's Engineer-in-charge .


5.4 All recommendations and instructions of the grout manufacturer shall be followed by Contractor.

5.5 No grout shall be placed when the outside temperature is below 5<sup>0</sup>C unless special approval provisions are made against freezing.

#### **6.0 GROUT TYPES**

##### **6.1 Sand Cement Dry Pack And Ordinary Mortar Grout**

6.1.1 Cement shall be Portland cement conform to the requirements of IS 269:1976.

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6.1.2 Sand shall be mixed at two to one ratio (2:1) by weight with the cement with a ramming consistency and shall have a minimum compressive strength of 15 N/mm<sup>2</sup> at 7 days determined by test on 50 mm cubes per ASTM C109.

## 6.2 Non-shrink Cement Based Grout

6.2.1 Non-shrink Cementitious Grouts are used for static and low dynamic loading associated with column baseplates, sole plates, pumps, anchor bolts or in areas in conjunction with high operating temperatures.

6.2.2 Dimensional Stability/ Compressive Strength – The grout shall meet the requirement of ASTM C 1107 Grade C, when prepared according to manufacturer's instruction and tested at 4°C and 32°C.

6.2.3 Non-shrink cement-based grout must have a full range of consistencies, including dry pack, plastic and flowable state, to be suitable for use in a variety of applications.

6.2.4 Grout should be capable of being pumped flowable without segregation. Vibration only when expressly stated by manufacturer.

6.2.5 Grout working time shall be minimum of 60 minutes regardless of application consistency used.


6.2.6 The grout shall contain no metallic substances (catalyzed or non-catalyzed), aluminium powder, water reducing agents, fluidifiers, accelerators, super plasticizers, or other materials known to increase drying shrinkage and/ or compromise long-term durability.

6.2.7 Non-shrink cement-based grout shall have a minimum compressive strength of 50N/mm<sup>2</sup> at 7 days, as determined by test on 50 mm cubes per ASTM C109.

## 6.3 Non-shrink Epoxy Grout

6.3.1 Non-shrink Epoxy Grouts are used for chemical resistance and heavy dynamic loading associated with reciprocating compressors, large diesel and gas engines, pumps, crane rails and crushers.

6.3.2 Dimensional Stability Before Hardening – The vertical volume change at all times before hardening shall be between 0.0% shrinkage and 4.0% expansion when measured according to ASTM C 827 (modified for epoxy grouts by using an indicator ball with a specific gravity between 0.9 and 1.1).


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- 6.3.3 Dimensional Stability After Hardening – The length change after hardening shall be negligible (less than  $6.0 \times 10^{-4}$  mm/mm) when tested according to ASTM C 531.
- 6.3.4 Compressive Creep – The compressive creep at one year shall not exceed  $1.0 \times 10^{-3}$  mm/mm when tested under 2.8 Mpa constant load at 60°C according to ASTM C 1181.
- 6.3.5 Thermal Compatibility – The co-efficient of thermal expansion shall be less than  $5.4 \times 10^{-4}$  mm/mm/°C when tested according to ASTM C 531.
- 6.3.6 Compressive Strength – The 7 day compressive strength shall be minimum of 103.5Mpa when tested according to ASTM C 579 (Method B)
- 6.3.7 Placeability – The grout shall be capable of maintaining at least a flowable consistency for a minimum of 30 minutes at 21°C
- 6.3.8 Grout shall be a 100% solids system with the ability to be placed in flowable state.
- 6.3.9 Non-shrink epoxy shall have a minimum allowable compressive strength of 80 N/mm<sup>2</sup> at 7 days as determined by test on 50 mm cubes per ASTM C579, method B.
- 6.3.10 Epoxy grouts whose resin component has an SPI rating higher than II shall not be used due to potential local atmospheric contamination making the installation area hazardous.

## 7.0 GROUT TYPE SELECTION

- 7.1 When the application is an unobstructed bearing plate or void which is not subject to impact or vibrations and allows the easy placement of grout without undue man-hour expenditure, use a sand cement dry pack or an ordinary mortar grout.
- 7.2 If one of the criteria cited in 7.1 is not met (i.e. obstructed bearing plate or void or subject to impact or vibration) then use a prepackaged, pre-measured, non-shrink. Cement based grout.
- 7.3 Grout type selection other than the above mentioned shall be in accordance with the table 10.1 of this procedure.


## 8.0 SURFACE PREPARATION

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- 8.1 All surfaces to be grouted, including anchor bolts shall be entirely free of oil, grease, dirt, wax, laitance, curing compounds and other foreign substances that may interfere with complete bearing or bondings.
- 8.2 Inspect the base plate or anchor system for rust, oil and other deleterious substances that may affect the bond or performance of the grout.
- 8.3 Confirm newly placed concrete has been cured sufficiently to attain it's design strength and limit further shrinkage.
- 8.4 Roughen all concrete surfaces by sandblasting or other mechanical means to assure bond. Loose or broken concrete shall be removed.
- 8.5 When removing laitance, a hand-held pneumatic chipping hammer shall be of the largest tool, contractor shall take the utmost care to prevent any possible structural damage that could be caused by improperly or negligently removing the laitance.
- 8.6 For foundation of vertical equipment having skirt at bottom, adequate numbers of drain pipe shall be provided.
- 8.7 When any cement-based grouts are used, concrete surfaces shall be saturated with water for 24 hours prior to grout placement. Excess water shall be removed just prior to grouting. In case of epoxy grout do not wet concrete substrate.
- 8.8 When epoxy grouts are used, all surfaces shall be made completely dry prior to grouting.
- 8.9 Forms for grout shall be built of materials with adequate strength to withstand the placement of grout.
- 8.10 Forms for grout shall be watertight. An approved form release agent shall be used for easy form release.
- 8.11 Forms shall be 100 ~ 150 mm higher than the baseplate on one side of baseplate when using hydrostatic head pressure for placement.
- 8.12 Air relief holes a minimum of 6mm in diameter (Vent tubes) must be provided when required by the baseplate configuration to minimise the amount of air entrapped under the plate.

## 9.0 LEVELING AND ALIGNMENT

- 9.1 Prior to commencing grouting equipment bases, column based or anchor bolts, leveling and alignment shall be performed to place and maintain said items in their final position during grouting.

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9.2 A minimum grout space of 25 mm shall be provided unless specified otherwise on the drawing.

9.3 All metal surfaces which are to be in direct contact with the grout shall be thoroughly cleaned and made free of all grease, oil, dirt, wax or other, foreign substance.

## **10.0 MIXING**

10.1 Mixing and pouring of ordinary cement shall be performed at ambient temperature of over 5°C.

10.2 Grout types shall be mixed according to manufacturer's recommended procedures.

10.3 Epoxy grout component ratios shall not be changed from that recommended by the manufacturers. No solvents or thinners shall be added to the mix. Pour the can of hardener into pail of resin and mix for atleast one minute and until the mixture is uniform in color. Pour the chemical components into the mortar mixer and add aggregate. Mix until aggregate is uniformly wetted. Overmixing shall cause air entrapment in the mix.

10.4 The amount of water added to a non-shrink cement-based grout shall not exceed the manufacturer's maximum recommended water content to determine its consistency. The lowest water/grout ratio needed to get the grout in place should be used.

10.5 Mix the cementitious grout for 3 to 5 minutes for uniform consistency.

## **11.0 PLACEMENT**

11.1 Grout placement shall proceed in a manner that assure the filling of all voids and the intimate contact of grouting materials with surfaces to be grouted.

11.2 The placement of grout shall be rapid and continuous so as to avoid cold joints under any base plate. For open frame-type skid equipment, grouting mortar shall be poured up to the top level of the skid to prevent rain water from accumulating in the skid.

11.3 All grouting shall be done in one direction only, placing grout on one side and working it to the other to avoid trapping air. Placement will be such as to provide full and uniform bearing under all foundation bearing surfaces. Retempering of grout by adding more water after stiffening is not permitted.

11.4 Hydrostatic head pressure shall be maintained keeping the level of the grout in the headbox above the bottom of the base plate. The headbox shall be filled to the maximum level and the grout worked down to top of baseplate. All exposed grout shall be provided with a 25 mm, chamfer, unless otherwise directed by purchaser's



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Engineer-in-charge. Epoxy cannot be cut back after set. The final level of the grout shall be as installed with all chamfer edges built into the formwork.


- 11.5 The grouting mortar shall be poured into the gap between equipment and foundation as referred in Table 10.1. Mixing ratio of grouting mortar shall be as specified in Table 10.2 Standards of Mixing Ratio of Mortar for Ordinary Cement Grout.

Table 10.1

		Mortar Pad		Anchor pocket Grouting		Base & Frame Grouting	
		Ordinary Mortar	Non-Shrink Mortar	Ordinary Mortar	Non-Shrink Mortar	Ordinary Mortar	Non-Shrink Mortar
(I) Mortar Pad or Liner Type	Static Equipment such as Tank, Tower and H.Ex.	A	NA	A	NA	A	NA
	Rotating Equipment such as Pump, Blower	NA	A	NA	A	NA	A
	Tower > 10 m	A	NA	NA	A	A	NA
	Skid Mounted Equipment	A	NA	NA	A	A	NA
	Structural work	A	NA	A	NA	A	NA
	Heavy Rotating Equipment such as Compressor, Steam Turbine	Non-shrink Epoxy Grout / As per Specific Job Requirements					
(II) Equipment Manufacturer's Standard	All Equipment	By Equipment Manufacturer's Specification / Instruction					

Notes : Symbol in above Table  
A : Applicable  
NA : Not Applicable.

Table 10.2

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Specification of Grouting				Mixing Ratio (in weights)			Weight % of water against Cement	Curing Time
				Ordinary Cement	Sand	Gravel		
Mortar Pad	Ordinary Cement	--		1	1	--	< 30	7 days or more.
Grouting of Anchor Pocket	Ordinary Cement	Depth of Anchor Box (mm)	upto 300	1	2	--	40.50	7 days or more.
			over 300	1	2	3		
Grouting of Frame of Equipment	Ordinary Cement	Grouting thickness up to 100 mm		1	2	--	40.50	7 days or more.
		Grouting thickness over 100 mm		1	2	3		

Notes :

- (1) The above table shows, as reference the standard of mixing ratio, water % against cement and curing time of mortar, which shall be used for mortar pad, grouting of anchor bolts, liners and frame of equipment.

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- (2) Standard of materials for making mortar shall be as shown below and be free from harmful or detrimental substances such as alkali, acid, oil, salt etc.
- (a) Portland cement shall be used as “ordinary cement”.
  - (b) Clean sand confirming to IS 1542 with grain size of between 0.3 mm and 2.5 mm shall preferably be used.
  - (c) Clean gravel with grain size of 5 mm to 10 mm shall preferably be used.
  - (d) Water to be used shall not contain detrimental substance as mentioned above, or solid material.

## 12.0 CURING

- 12.1 Grout shall be cured according to manufacturer’s specifications and recommendations. It shall be kept moist for a minimum of three days.
- 12.2 Forms shall remain in place with a minimum of 24 hours regardless of whether grout is cement-based or epoxy.
- 12.3 Cement-based grout shall be protected from extreme drying conditions.
- 12.4 Epoxy grout shall not be wet cured.
- 12.5 The temperature of the baseplate, concrete foundations and grout shall be maintained between 4<sup>0</sup>C and 32<sup>0</sup>C during grouting and for a minimum of 24 hours thereafter.

## 13.0 TESTING

- 13.1 Field testing of non-shrink grouts shall be directed by purchaser’s Engineer-in-charge. Contractor shall be responsible for preparing, storage, curing and transporting the test samples to a laboratory for testing, as required by purchaser’s Engineer-in-charge.
- 13.2 The grout shall develop its required compressive strength and be tested under ASTM C 109 for non-shrink cement-based grout and ASTM C 579 for epoxy grout. Nine cubes shall be made for each grout delivery. The cubes shall be tested in groups of three at 24 hours, 7 days and 28 days.
- 13.3 Test results shall be immediately transmitted to purchaser’s Engineer-in-charge.

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