SECTION 03 6000

GROUTING

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This section includes Portland cement grout, non-shrink epoxy grout, and non-shrink cementitious grout that will be used in structural applications (i.e., the grout will be part of a load path)\* vs. nonstructural applications (e.g., minor / local concrete surface repair, etc.).

\* Although grout for prestressed, precast concrete (ref. 03 4100) and reinforced masonry (ref. 04 2220) is structural, its use in those applications is too specialized to be included herein; therefore, Sections 03 4100 and 04 2220 have their own grout requirements.

This section has been written to meet requirements of buildings classified as Natural Phenomena Hazard (NPH) Risk Category (RC) I, II, III or IV, and projects classified as ML-3 or ML-4. In general, this section does not apply to nuclear facilities. This section may apply to facilities that, because of the low amount of nuclear material at risk, are classified as RC IV.

For nuclear applications, ML-1/ML-2 (and ML-3 potentially), and NPH Design Category (NDC) -3, this specification must be further developed. This would include considerations related to “Submittals,” “Quality Assurance,” “Field Quality Control,” etc.

This template must be edited for each project.  In doing so, specifier must add job-specific requirements.  Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.  Once the choice is made or text supplied, remove the brackets.  The specifications must also be edited to delete specification requirements for processes, items, or designs that are not included in the project -- and specifier’s notes such as these.  To seek a variance from requirements in the specifications that are applicable, contact the Engineering Standards Manual Structural [POC](http://engstandards.lanl.gov/POCs.shtml#struc). Please contact POC with suggestions for improvement as well.

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1. GENERAL
	1. SUMMARY
		1. Section Includes:
			1. Portland cement grout
			2. Non-shrink epoxy grout
			3. Non-shrink cementitious grout

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List sections specifying installation of products included in this section and indicate specific items.

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* + 1. Related Sections:
			1. Section 03 3001 -- *Reinforced Concrete*: [Formwork Products] [, and] [Joining existing concrete with new concrete].
			2. Section 05 0520 – *Post-Installed Concrete and Grouted-Masonry Anchors – Normal Confidence*: [Use of an anchorage system consisting of grout and an anchor rod, wherein the latter consists of concrete reinforcing steel (i.e., rebar)].
			3. Section 05 0521 – *Post-Installed Concrete Anchors – High Confidence*: [Use of an anchorage system consisting of grout and an anchor rod, wherein the latter consists of concrete reinforcing steel (i.e., rebar)].
			4. Section 05 1000 – *Structural Metal Framing*: [grouted baseplates, bearing plates, and/or leveling plates].
	1. REFERENCES

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List reference standards included within text of this section. Edit the following for Project conditions.

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* + 1. American Concrete Institute:
			1. ACI 301 - Specifications for Structural Concrete.
			2. ACI 318 - Building Code Requirements for Structural Concrete.
		2. ASTM International:
			1. ASTM C33 - Standard Specification for Concrete Aggregates.
			2. ASTM C40 - Test Method for Organic Impurities in Fine Aggregates for Concrete.
			3. ASTM C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. Cube Specimens).
			4. ASTM C150 - Standard Specification for Portland Cement.
			5. ASTM C191 - Test Method for Time of Setting of Hydraulic Cement by Vicat Needle.
			6. ASTM C307 - Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings.
			7. ASTM C531 - Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
			8. ASTM C579 - Test Method for Compressive Strength of Chemical-Resistant Mortars, Grouts, monolithic Surfacings and Polymer Concretes.
			9. ASTM C827 - Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures.
			10. ASTM C1090 - Standard Test Method for Measuring Changes in Height of Cylindrical Specimens of Hydraulic-Cement Grout.
			11. ASTM C1107 – Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
	1. ACTION SUBMITTALS

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Only request submittals needed to verify compliance with Project requirements. For example, due to the way in which the three types of grout are specified in Part 2, 1.3.A is needed to verify compliance only for Portland cement grout.

Retain the “inspections option” in the Field-QC paragraph (E) below if this option is also to be retained in the Field-QC article in PART 3.

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* + 1. Product Data: Submit product data on grout, fine aggregate (demonstrating compliance with ASTM C33 and C40), and [\_\_\_\_\_\_\_\_].
		2. Manufacturer's Installation Instructions: Submit manufacturer’s instructions for mixing, handling, surface preparation and placing epoxy type and non-shrink type grouts.
		3. Manufacturer's Certificates of Compliance: Certify [non-shrink cementitious grout] and [Insert Other Products Here] meet or exceed [ASTM C 1107] and [Insert Other Specified Requirements Here].
		4. Mix Designs: Submit proposed mix design [of each class of grout] to LANL Site Technical Representative (STR) for review prior to commencement of Work.
		5. Field Quality-Control Results: Submit results of Subcontractor-furnished tests [and inspections].
	1. SUSTAINABLE DESIGN SUBMITTALS
		1. Manufacturer's Certificate: Certify products meet or exceed specified sustainable design requirements related to recycled content and point of origin of materials.

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Edit material certifications list to suit products specified in this section and Project sustainable design requirements.

If both sustainability requirements shown here are determined to be cost-prohibitive to the project, delete SUSTAINABILITY DESIGN SUBMITTALS section.

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* + - 1. Materials Resources Certificates:
				1. Certify recycled material content for recycled content products.
				2. Certify source for regional materials and distance from Project site.
	1. QUALITY ASSURANCE

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Use this article to specify compliance with overall reference standards affecting all products and installation included in this section.

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* + 1. The work shall be subject to inspection at all times by LANL and, if applicable, LANL’s Independent Testing Agency for the purpose of determining that the work is properly executed in accordance with this specification. Failure to detect defective workmanship or material during any interim inspection shall not constitute acceptance of workmanship and materials.
		2. Acquire all materials from same source as used to produce the specific mix design for all work. Formally notify LANL of any material source changes prior to grout placement including the test agency test documentation. The subcontractor must provide LANL a certificate of conformance prior to the initial placement that confirms the source of the constituents, that tests confirm compliance, and that these sources are the same for the mix design testing and the placed mix.
	1. DELIVERY, STORAGE, AND HANDLING
		1. Section 01 6000 - *Product Requirements*: Requirements for transporting, handling, storing, and protecting products.
		2. Deliver grout in manufacturer's unopened containers with proper labels intact.
		3. Store grout in a dry shelter, protected from moisture and, for prepackaged grout, if applicable, maintained at a temperature required by manufacturer.
	2. ENVIRONMENTAL REQUIREMENTS
		1. Section 01 6000 - *Product Requirements*: Environmental conditions affecting products on site.
		2. For prepackaged grout, do not perform grouting if ambient temperature exceeds that which is specified by manufacturer. In the case of non-prepackaged, Portland cement grout, comply with ACI 301.
		3. For prepackaged grout, maintain minimum temperature specified by manufacturer before, during, and after grouting, until grout has set. In the case of non-prepackaged, Portland cement grout, comply with ACI 301.
1. PRODUCTS
	1. SUSTAINABILITY CHARACTERISTICS

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Edit sustainable design requirements to suit content of this section and Project sustainable design requirements.

If both sustainability requirements shown here are determined to be grossly prohibitive to the project, delete SUSTAINABILITY CHARACTERISTICS section.

It is recognized that the nature of grout materials significantly inhibits the use of high recycled content. However, this section is retained such that to encourage specification towards those manufacturers that can provide high recycled content that meets design requirements. If high recycled content grout is not available to meet the requirements of the design, delete this section.

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* + 1. Materials and Resources Characteristics:
			1. Recycled Content Materials: Furnish manufacturers certification of production with maximum available recycled content. [including:] [.]

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List materials specified in this section required to have recycled content.

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* + - * 1. [\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.]

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List materials specified in this section required to be regional materials.

Note to specifier: It is recognized that many grout manufacturers will not be local to LANL. However, this section is retained such that to encourage specification towards those manufacturers that can provide local materials. If this is not consistent to the requirements of the project, delete this section.

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* + - 1. Regional Materials: Furnish materials extracted, processed, and manufactured within 500 miles of Project site [including:] [.]
				1. [\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.]
	1. PORTLAND CEMENT GROUT MATERIALS
		1. Portland cement: ASTM C150, Type I and II.
		2. Water
			1. Potable; containing no impurities, suspended particles, algae or dissolved natural salts in quantities capable of causing:
				1. Corrosion of steel.
				2. Volume change increasing shrinkage cracking.
				3. Efflorescence.
				4. Excess air entraining.

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Note to specifier: Grout used to fill spaces under base plates of 2 in or less does not require coarse aggregate. Spaces greater than 2 in require consideration of coarse aggregate to control heat effects of the hydration process. Contact the manufacturer of the grout to obtain guidance on size and amount of coarse aggregate necessary.

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* + 1. Fine Aggregate
			1. Washed natural sand.
			2. Gradation in accordance with ASTM C33 and represented by smooth granulometric curve within required limits.
			3. Free from injurious amounts of organic impurities as determined by ASTM C40.
		2. Mix
			1. Portland cement, sand and water. Do not use ferrous aggregate or staining ingredients in grout mixes.
	1. RAPID-CURING EPOXY GROUT

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Typically, epoxy grout is applicable to projects involving dynamic/impact loading, vibration, or chemical attack considerations. These grouts are ideal for applications where precise change in elevation while curing is required. Additionally, these grouts can be tailored to provide improved properties related to: high early strengths, high chemical, heat, acid, and fatigue resistance.

The products listed below (in descending order of precision/performance) meet the descriptive specifications as well as the properties in para. 2.3.B; thus, if a product other than those listed is selected, author must be sure there are no conflicts amongst / between these affected paragraphs.

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* + 1. Manufacturers:
			1. Five Star Products, Inc.: Five Star HP Epoxy Grout.
			2. Dayton Superior: Epoxy Grout J55.
			3. ITW Polymer Technologies: Escoweld 7505E/7530
			4. Sika Corp.: Sikadur 42, Grout-Pak
			5. [\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_] Model [\_\_\_\_\_\_\_\_].
			6. Substitutions: [Section 01 2500 – Substitution Procedures] [Not Permitted-No Substitutions].

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

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Edit the following descriptive specifications to identify project requirements and to eliminate conflicts with manufacturers’ products specified above.

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* + 1. Rapid-Curing Epoxy Grout: Precision, high strength, minimal shrinkage, 100% solids, three-component epoxy grout. Rapid-curing, low creep, high effective bearing area, high-vibration and chemical resistance.

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Use in grouting base plates, machinery.

When amount of height change is critical to application, keep bracketed items and specify applicable height-change requirements.

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|  |  |  |
| --- | --- | --- |
| Property | Test | Result |
| Compressive Strength | ASTM C579 | [14,000] psi at 7 days |
| Tensile Strength | ASTM C307 | [2,100] psi minimum |
| Coefficient of Expansion | ASTM C531 | [20x10-6] per degree F |
| Linear Shrinkage | ASTM C531 | [0.04%] |
| [Early Age Height Change (Plastic State) | ASTM C827  | Minimum change in height [0.10%]Maximum change in height [0.40%]] |
| [Height Change of Hardened Grout  | ASTM C1090 | Minimum change in height [0%]Maximum change in height [0.5%]] |

* 1. NON-SHRINK CEMENTITIOUS GROUT

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These grouts are typically less resistant to heat, chemical attack, and fatigue. These grouts tend to be less expensive than epoxy, but more precise than non-prepackaged cementitious grout.

The products listed below meet the descriptive specifications in para. 2.4.B, as well as the properties in para. 2.4.C; thus, if a product other than those listed is selected, author must be sure there are no conflicts amongst / between these affected paras.

If high-strength (i.e., 10,000 psi or greater) and/or high-precision grout is required, the following products should be considered for use (and added to listing below if use is desired/ required):

* Five Star Products, Inc.: High-Strength Grout.
* Unisorb Installation Technologies: V-1 Non-shrink Grout.
* QUICKCRETE: Non-shrink Precision Grout.

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* + 1. Manufacturers (listed in descending order of precision / performance):
			1. QUICKCRETE: Non-shrink General Purpose Grout.
			2. Dayton Superior: 1107 Advantage Grout.
			3. Five Star Products, Inc.: Five Star Grout,
			4. L & M Construction Chemicals, Inc.: Crystex.
			5. [\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_] Model [\_\_\_\_\_\_\_\_].
			6. Substitutions: [[Section 01 2500 – Substitution Procedures] [Not Permitted- No Substitutions].

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

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Edit the following descriptive specifications to identify project requirements and to eliminate conflicts with manufacturers’ products specified above.

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* + 1. Non-shrink Cementitious Grout: Pre-mixed ready for use formulation requiring only addition of water; non-shrink, non-corrosive, non-metallic, non-gas forming, no chlorides.
		2. Properties: Certified to maintain initial placement volume or expand after set and meet the following minimum properties when tested in accordance with ASTM C 1107:

|  |  |  |  |
| --- | --- | --- | --- |
| Property | Test | Time | Result |
| Early Age Height Change (Plastic State) | ASTM C827 |  | Minimum change in height [0.0%]Maximum change in height [4.0%] |
| Height Change of Hardened Grout  | ASTM C1090 |  | Minimum change in height [0%]Maximum change in height [0.3%] |
| Compressive Strength\* | ASTM C 1107 (ASTM C109 modified) | 1 day |  2,000 psi |
| 7 days |  5,000 psi  |
| 28 days |  6,500 psi  |

\* For grouts, compressive strength is typically reported for multiple consistencies (e.g., plastic, flowable and fluid, etc.). Since the number and /or names of the consistencies can vary from manufacturer to manufacturer, the compressive strength given in the table is the lowest strength that all manufacturers report (i.e., fluid / max. water).

* 1. FORMWORK
		1. Refer to Section 03 3001 for formwork requirements.
	2. CURING
		1. Prevent rapid loss of water from grout during first 48 hours by use of approved membrane curing compound or with use of wet burlap method.
1. EXECUTION
	1. EXAMINATION
		1. Verify areas to receive grout.
	2. PREPARATION
		1. Remove defective concrete, laitance, dirt, oil, grease and other foreign material from concrete surfaces by brushing, hammering, chipping or other similar means until sound, clean concrete surface is achieved.
		2. Rough concrete lightly, but not enough to interfere with placement of grout.
		3. Remove foreign materials from metal surfaces in contact with grout.
		4. Align, level, and maintain final positioning of components to be grouted.
		5. Saturate concrete surfaces with clean water; remove excess water, leave none standing.
	3. INSTALLATION - FORMWORK
		1. Construct leak proof forms anchored and shored to withstand grout pressures.
		2. Install formwork with clearances to permit proper placement of grout.
		3. For dry packing of grout, use braced backboards with sufficient strength to pack grout against.
		4. Coat all formwork with approved form release agents
	4. MIXING
		1. Portland Cement Grout:
			1. Use proportions of 2 parts sand and 1 part cement, measured by volume.
			2. Prepare grout with water to obtain consistency to permit placing and packing.
			3. Mix water and grout in two steps; pre-mix using approximately 2/3 of water; after partial mixing, add remaining water to bring mix to desired placement consistency and continue mixing 2 to 3 minutes.
			4. Mix only quantities of grout capable of being placed within 30 minutes after mixing.
			5. Do not add additional water after grout has been mixed.
			6. Capable of developing minimum compressive strength of [2,400] psi in 48 hours and [7,000] psi in 28 days.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

* + 1. Mix and prepare rapid curing epoxy grout in accordance with manufacturer's instructions.
			1. Capable of developing compressive strength of [14,000] psi in 7 days.
			2. Field proportioning of epoxy grouts shall not be permitted.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

* + 1. Mix and prepare non-shrink cementitious grout in accordance with manufacturer's instructions.
			1. Capable of developing minimum compressive strength of [2,000] psi in 24 hours, [5,000] psi in 7 days, and [6500] psi in 28 days.
		2. Mix grout components in proximity to work area and transport mixture quickly and in manner not permitting segregation of materials.
	1. PLACING GROUT
		1. Place grout material quickly and continuously.
		2. Do not use pneumatic-pressure or dry-packing methods.
		3. Apply grout from one side only to avoid entrapping air.
		4. Do not vibrate placed grout mixture, or permit placement when area is being vibrated by nearby equipment.
		5. Thoroughly compact final installation and eliminate air pockets.
		6. Do not remove leveling shims for at least 48 hours after grout has been placed.
		7. Where grout depth will exceed 2 inches, place grout using two pours. The first pour shall be such that the second pour can be conducted with a depth of 1 to 2 inches.
	2. CURING
		1. Immediately after placement, protect grout from premature drying, excessively hot or cold temperatures, and mechanical injury.
		2. After grout has attained its initial set, keep damp for minimum of 3 days.
	3. FIELD QUALITY CONTROL
		1. Field [inspection and] testing will be performed in accordance with [ACI 301] [ACI 318] and under provisions of Section 01 4000 - Quality Requirements. [\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.]

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Retain either or both of the following two (2) Paragraphs as applicable given the intended use of this Section (e.g., if epoxy grout has been deleted from previous portions of the Section, then the 1st of the 2 paras. should be deleted, etc.).

Five Star Products recommends requiring compressive-strength testing for QC. And their “Handbook” points out that there are 3 different test methods in ASTM C579, and that the difference between the results from them can be as much as 2000 psi. This is the reason for the subparagraph for the epoxy-grout paragraph.

Other than the subparagraph applicable to testing epoxy-grout, the verbiage of these paragraphs was adapted from ACI 301 Section 13 para. 13.1.4.4(c).

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* + 1. Epoxy grout: Test compressive strength per ASTM C579. Strength is satisfactory if 7-day compressive strength is equal to or exceeds specified compressive strength.
			1. The test method used shall be the same as that which is applicable to PART 2.
		2. Cementitious grout: Test compressive strength per ASTM C109. Strength is satisfactory if 28-day compressive strength is equal to or exceeds specified compressive strength.
		3. Tests of grout components may be performed to ensure conformance with specified requirements.

END OF SECTION

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Do not delete the following information:

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THE FOLLOWING REFERENCE IS FOR LANL USE ONLY

This project specification is based on LANL Master Specification Section 03 6000 Rev. 3, dated May 8, 2017.