

IAI Procedure for performing a concrete Air, Slump, & Cylinder Review
(Minimum once per year)

General Requirements and Sampling: To determine if the project needs a federally required project review for concrete air, slump, and cylinder check the Project Summary sheet and see if boxes are checked “YES” in the concrete area (Agency/Contractor). If so, you will need to make sure both the field and plants are covered for the year.

1. First review the project proposal to check concrete mix designs, Special Provisions, or any other unusual circumstances that may be spelled out (admixtures, water reducer allowed, supers, spread test, placement, etc.).
2. Once the job is underway, check Metro Inspection’s “Request for Inspection” orders database DAILY to follow progress; here is where some advance planning and coordination comes into play:
 - If you need an IAI check of field personnel ONLY, check Metro Inspection’s orders database in the EARLY AM (just after 6:00) to see which plant the job S.P. mix is coming out of; print out a copy. If the plant has already been covered for the year, you must still determine who is performing the plant Q/C and agency Q/A for the pour that day (for the cross-reference). This is accomplished by visiting the plant after the field review or calling the plant Q/C to find out who was doing the work. If no one is there, check Metro Inspection’s plant diary for names - need both Q/C and QA personnel.
 - If you need BOTH the field personnel and plant you should check Metro Inspection’s orders database LATE in the afternoon of the day before the pour; print out a copy. This will allow you to coordinate your schedule to observe the Q/C plant setup; sometimes this is done in the late afternoon for the next day’s pour, other times it may be done early in the morning (around 5:00) so set your schedule accordingly. Go to the plant first and do the IAI review (you may be able to coordinate your sample with plant Q/C and Metro Inspection’s Q/A for a 4-way split). When finished at the plant, follow the first truck load out to the field to do the field review on the first load of the pour for the day.
3. If you are unsure of the testing location, call the inspector/tester or check maps for the exact location. If you are going out to the field on a different day than performing a plant contact (review), try to arrive on site for the field review approximately 20 - 30 minutes ahead of time. This will allow you time to evaluate the site, make contact with the tester, and make sure you don’t miss the first truck (sometimes it will get to the site early).
4. As soon as you arrive locate the tester/inspector you are there to observe, introduce yourself as the Mn/DOT IAI and explain your intentions. If they question the need or your frequency, be sure to explain the IAI Schedule of Materials Control lists required reviews as minimums, and we may need additional tester reviews or test result data for the project. Be sure to visually check their certification card, to be sure that they are certified in the area of Concrete Field 1 (or ACI), and that it is valid and has not expired. Certified technicians are required to have the card on their person and present a valid card on demand of an IAI while performing any Agency testing (pg.8 - Oct. 2007 Technical Certification Handbook). If you simply “take their word” on certifications and check them latter in the database, you may end up with an

expired card or uncertified person doing the testing. Write down their full name, certification number, and company or agency in your diary. If they do not have their card on them (or in their truck), inform them they must have a valid certification card to do testing. It is their responsibility to have it available upon request anytime they are performing Agency testing; do not perform a review and schedule a revisit time ASAP. At the revisit they must present their valid card. Either way, send a report to the Project Engineer detailing the situation and requirement for certified testers on their project.

Reminder: When in the field, the “tester” only does the actual testing and reports results to the “field inspector”, (they do not make placement decisions). The “field inspector” has the authority to make placement decisions, adjust air/slump to make spec, reject loads, check forms, grade conditions, etc. Any one person may perform both functions, but if there are 2 separate persons in the field performing separate duties of tester and field inspector (e.g. city inspector hires a testing firm) then the field inspector should still be certified in Concrete Field 1 and have equipment handy in case mud goes bad and needs retest(s) after the tester has left the site.

5. Check the air pot’s current year calibration date and pot identification. There should be a label on the pot or case listing the calibration year. This date/year must be recorded in your diary and checked every time. Remember you should not test on equipment that is not calibrated for the current season. Make sure the air pot works (no air leaks, pump works, gauge works, needle stabilizes and can be read; if pot leaks it should be taken out of service and not used until repaired and recalibrated, etc.). If the test equipment is not calibrated for the current season, you should not do the IAI review that day. Tell the technician to get the air pot calibrated for the current season ASAP and set up a revisit to check and make sure they did the calibration and correctly labeled the pot. Explain to them they should not be doing any testing on uncalibrated equipment (all test results will be considered unreliable and thus invalid in case penalties may be levied, e.g. low air %). In an emergency (concrete waiting to pour) you may elect to allow the technician to use your IAI air pot, but they must still repair their own ASAP and schedule a revisit.

Note all of the above in your diary.

6. Check over the rest of the gear and make sure they have the correct equipment to perform the test - wheelbarrow or buckets, scoop, water, squeeze bottle, rubber mallet, 5/8” rounded tip rod, 3/8” rounded tip rod, 4x8 or 6x12 cylinders with cover, thick and stable slump board, tape measurer, also check condition of slump cone - no deformities or concrete stuck inside, etc.
7. When the truck arrives on the job, make sure to check the “Certificate of Compliance” (Certificate) ASAP (not weigh scale ticket). A good practice is to hold onto this until testing is complete, since you will be recording data and signing bottom. The things the tester (and IAI) should check for are:
 - Correct Project S.P. (and location).
 - Correct contractor and plant location (#).
 - Correct concrete mix and note if water reducer is added to the batch (you are not required to verify dosages - this is Metro Insp.’s and the field inspector’s responsibility).

- Batch date and TIME batched (air-entrained mix cannot be placed if it is over one hour old since batching). Note time truck arrived on site; record time and initial the Certificate near the printed batch time.
- If it is the first load of the pour, make sure the plant Q/C has signed the Certificate. You cannot place the load without a Q/C signature per Spec.
- If after performing the slump test it is determined that water may be added to bring up the slump to working range be sure someone records amount of water added to the load, and it does not exceed “water allowed” amount. A retest of the slump/air should occur after water/AEA is added on the job.

All of the above information should be written down in your dairy for database entry. If the “Certificate of Compliance” does not have all of the correct information, Q/C signature (only on first load of the pour), or truck is older than 1 hour, the load is out of Spec. compliance and should be rejected. Remember - this is not your call as an IAI to reject a load - but that of the on site field inspector. You “recommend” to them that they follow your advice on Spec’s. If they choose not to, let them know your job is to make out a report on everything that has transpired and send copies to the Project Engineer, Mn/DOT District Materials Engineer, and the Federal Highway Administration (usually this “persuades” them to take your advice).

8. Observe tester/inspector at the rear of the ready-mix truck to review how they take the concrete sample (Concrete Manual 5-694.504). The sample shall:
 - Be taken ONLY by the person being observed - not a helper.
 - Be sampled after the first ¼ cubic yard has been discharged.
 - Be at least 1 cubic foot for strength tests - double this amount for doing all 3 tests (air content, slump, and cylinder) - have extra mud available.
 - Be sampled a minimum of 2 spaced intervals during discharge.
 - (Should) be obtained before water is added to the load at the jobsite. If any water is added, air and slump should be retested.
 - Be thoroughly remixed before beginning tests.
 - Be a “truly representative” sample - normally obtained by passing a receptacle, i.e. square nose shovel (NO SCOOPS!) or bucket(s) completely through the chute discharge stream or by completely diverting the chute into sample container (wheelbarrow, tub, or buckets). Use your IAI judgment to any special conditions during placement where the above sampling procedure is not reasonable or safe.
(Taking concrete samples at point-of-placement rather than point-of-delivery is always preferable. Special situations may occur which create difficulties in sampling and transporting samples taken from the point-of-placement. When this occurs, sampling at the point-of-delivery is satisfactory but only after running correlation tests between the 2 sampling locations. If necessary – modify sampling procedures to fit a specific situation (from Concrete Manual 5-694.501).

Start tests for temperature, then air content, and finally slump - normally in this order - within 5 minutes of obtaining the sample. Complete these tests expeditiously.
Start molding cylinders within 15 minutes of obtaining the sample.

Note: Use only new concrete from your original sample for each test - DO NOT allow the tester to use any portion of concrete from a previous test in the next test. For example, if they run short of sampled concrete for the slump or cylinder test, they cannot use a portion of mud from the air test or vice-versa. Also, if the contractor chooses not to wait for the test results before pouring and the test fails - ANY concrete placed will be subject to penalty and the corresponding price reductions, or remove and replace.

9. If the tester does a concrete temperature test, do it first - be sure it has at least 3" of concrete in all directions around the sensor, pinch off around the sensor, leave it in at least 2 minutes (or until it stabilizes), record to nearest 1° F.

Note: IAI does not require a review of the temperature test, but use your judgment - if you are placing concrete with air temps under 40° F or over 90° F it would be wise for the tester to check the concrete temp to make sure it is within the specified range of 50° - 90° F. If it is not - recommend they must take corrective action.

Air Content Test: Usually do the air content test (Concrete Manual 5-694.541) first - (before slump and cylinder - if air fails, it makes no sense to do slump/cylinder) we are looking for target of 6.5%. Mix knowingly cannot be placed if it falls outside of the 5 - 8% range. Remember - we want 6.5% air content - contractor cannot, for example, run all day uncorrected with an e.g. 5.3 % or 7.7 % because it is "within range", they must call in an air change to the plant. Note: If AEA is added onsite by the driver to bring up air content to 6.5% it must first be diluted with water and thoroughly mixed in a bucket, then added to load once as needed (not dumped in load full strength - this will create pockets of very high air content in the mix). To begin the air test, first dampen the interior of pot and place on flat, level, firm surface. Complete test as per ASTM-Mn/DOT Concrete Manual 5.694.541 and ACI C/231-04 Subsection 8.1 as follows:

1. Obtain a representative, mixed, sample of concrete. 3 equal lift layers.
2. 25 rods per lift - evenly distributed over the cross section. Rod the bottom layer throughout its depth, the rod shall not forcibly strike the bottom of the pot. Do not permit "stirring" of the mix in the pot - rod must come out of mix completely on each stroke.
3. After each layer is rodded, tap the sides of the pot smartly 10 - 15 times with a rubber mallet to close voids made by the rodding.
4. In rodding the second and third layers, penetrate the surface of the previous layer about 1".

Note: ACI permits vibration in lieu of rodding on air tests of 3" slump or less but Mn/DOT does NOT allow vibration of any air content test. Therefore, Metro Materials' policy is do not use a vibrator on any Agency air tests.

5. Strike off 3rd layer with sawing motion of strike-off bar or rod as prescribed in test method ACI C/231-04 Subsection 8.1.4.
6. "Zero the gage" by pressing the release lever to free any air that may be trapped in the pump. Clean and dampen top cover, then thoroughly clean excess concrete from rim of air pot, being careful not to disturb the struck-off finish. This will insure a pressure-tight seal when clamped in place. It is OK to permit the "sprinkling" of a small amount of water on the top if needed, to aid in filling in any surface air voids.

7. Carefully place cover on top of air pot and clamp tight, making sure it is seated correctly with no material between the seal. Close the air bleeder (knurl nut) valve and fully open both petcocks on the cover.
8. Using a rubber syringe (or other accepted squeezable container), inject water through one petcock until water emerges, free of bubbles, from the opposite side petcock. Tapping meter gently will aid in expelling all air (do not tilt meter - water will run out of petcocks and let in air!); do not close petcocks yet. It is good practice to reverse process to insure all air has been expelled.

Note: If tester uses water that is freshly drawn from a pressurized line or valve on the ready-mix truck, or similar sources, it contains a considerable amount of small air bubbles. Water **MUST** be allowed to stand at least 10 minutes before use to permit the air contained in the water to escape. Not following this process may affect the test results.

9. Making sure knurl nut (air bleeder valve) is closed, pump air into the air chamber until the gage needle is on the initial pressure line. Allow a few seconds for the compressed air to cool to ambient air temperature. Stabilize the gage needle at the initial pressure line by slight pumping up or by bleeding off excess air thru the knurl nut - all while lightly tapping the gage by hand to get to the correct “calibrated initial pressure” line (usually 3 or 4).

Note: It is a good pot maintenance practice to pump up beyond the “calibrated initial pressure” line and then, after allowing the air to cool for a few seconds, adjust the gage needle back down to the correct “calibrated initial pressure” line (usually 3 or 4) by bleeding off excess air thru the knurl nut or by pumping up - all while lightly tapping the gage by hand.

10. Quickly observe petcocks to make sure there are no bubbles coming out of the water – if there is, the chamber has an air leak and the air pot is bad and needs repair. **DO NOT** continue the test with that pot until it is repaired and recalibrated.
11. Close both petcocks, then push down air valve to release air from the chamber to bowl, lightly tapping the gage to stabilize the dial (if air and or water leaks out from between the pot and lid, there is a bad seal and the test must be restarted - empty pot completely and start test from the beginning). Note: If the needle does not stabilize on a reading for at least 5 seconds - gage/pot is bad and must be repaired.
12. Read dial indicated air percentage to the nearest 0.1%.
13. The tester should promptly report results to contractor and field inspector (if they are not doing both) and properly record in their paperwork/diary.
14. When the test indicates air content outside the limits specified in Specification 2461.4A4B (5-8%) it is good practice to run an additional test immediately to verify the out of Spec. material. (This will strengthen the validity of the test results in case of “disagreements” between Agency and Prime Contractor.)
15. When complete, thoroughly clean base, cover, and petcock openings.

Slump Test: The next test will be the slump (Concrete Manual 5-694.530) test. This usually should be started immediately after a passing air test has been completed. Remember that for the required IAI observation check, a slump test must also be performed each time an air test is done – there will be no exceptions. (NO “estimated” slump tests for IAI reviews!) Equipment needed:

slump cone in clean and good condition, smooth rounded 5/8" diameter rod with rounded end, a firm slump board, scoop, and tape measure. Perform test as follows:

1. Obtain a representative sample of concrete - start test within 5 minutes of when sample was originally taken and thoroughly mixed.
2. Dampen the slump cone and place it on a firm, flat, level, moist, non-absorbent and rigid surface. (NOT on a truck tailgate!) Center the cone and hold firmly in place by standing on both foot pieces (or clamp down if using a base plate). If at any time during the test they happen to release pressure from any side of the cone and concrete leaks out of the bottom, this is a failure, and they must start over (retest).
3. Immediately fill the cone in 3 layers – each layer approximately one-third the volume of the mold or about 2 5/8" for the first layer and 6 1/8" for the middle layer.
4. Rod each layer with 25 strokes of the tamping rod. Uniformly distribute the strokes over the cross section of each layer. For the bottom layer, this will necessitate inclining the rod slightly and making approximately half the strokes near the perimeter, and then progressing with vertical strokes spirally toward the center. Rod the bottom layer throughout its depth, rod the second and top layer each throughout its depth so that the strokes just penetrate into the underlying layer - no more than 1". Do not allow the tamping rod to be in water at any time during the test (usually this happens between lifts, i.e. they put it in a pail of water).
5. In filling and rodding the top layer, heap the concrete above the mold before rodding is started, always keeping excess concrete maintained above the top of the cone. After the top layer has been rodded, the surface of the concrete is struck off flush with the top of the cone.
6. Continue to hold the mold down firmly, i.e. maintain a constant downward pressure, and remove excess spillage concrete from around the area surrounding the base (to preclude interference with movement of slumping concrete).
7. Remove the mold immediately from the concrete by slowly lifting the cone vertically, high enough to clear the coned-up concrete (operation taking 5 seconds +/- 2 seconds – remove slower as slump increases) with a steady, upward lift with no lateral or twisting motions. Complete the entire test from the start of the filling to the removal of mold without any interruption - within the elapsed time of 2 ½ minutes.
8. Immediately measure the slump by determining the vertical difference between the top of the mold and the displaced original center of the top surface of the specimen. Record to the nearest ¼ inch. This is usually accomplished by inverting the mold and carefully setting it next to the specimen. Then place the rodding bar across the top of the inverted mold, holding on to one end so it will not fall into the specimen, measure to the displaced center. If the tester uses a clamping base plate, carefully lift the u-shaped handle up and measure down to displaced center. If a decided "falling away" or "shearing off" of concrete from one side or portion of the mass occurs, or if the slump board is accidentally knocked or hit and the specimen moves before a measurement is taken, disregard the test and take a new test on another portion of the sample. This would be a procedural failure (retest).
9. Notify the contractor and inspector of the test results. If they are out of range, they must take appropriate corrective actions. Remember, IAI can only recommend appropriate actions.

Reminder: As of 2007 there is no longer a tolerance applied to the slump range for any mixes without water reducer (be sure and verify in Project Proposal – the change must be indicated therein at Section 2461). For example: 3A32 mix without water reducer - the slump is 1" - 3" with a 3 inch max. There is no longer 25% over slump range allowed. If the contractor elects to add water reducer to the mix at the plant,

and it is added at manufacturer's dosage requirements, this will increase the upper range by 1" - for example: 3A32 mix with water reducer added, the range is now from 1" - 4" with a 4" max. They will gain an inch of slump by adding water reducer. (See revised Table 2461-2 of 2005 Spec. book as contained in the Project Proposal.)

Cylinder Test: The final test will be the cylinder fabrication (Concrete Manual 5-694.511). For the making of strength specimens, place molds on a level firm foundation in a sheltered place where they can remain undisturbed and protected from direct sunlight and temperature extremes for at least 24 hours. If it is impossible to leave the cylinders where they were cast, or if they must be moved after casting, they must be immediately moved to a sheltered place upon casting. Standard mold size is 4"x 8" unless aggregate has a maximum size greater than 1.25", then use 6" X 12" cylinders (paving). White is Mn/DOT's preferred standard for concrete cylinders (they do not attract heat as much from the sun as black ones do). Use steel, fiber, or plastic molds. Perform test as follows:

1. Start casting cylinder within 15 minutes of taking and mixing representative sample of concrete.
2. Place the concrete in mold in 2 equal lifts (4x8"), rod each layer 25 times using a 3/8" rounded nose steel rod. For 6x12" molds, rod concrete 25 times per layer in 3 equal lifts using a 5/8" rounded nose steel rod. Uniformly distribute the rodding over the cylinder area and penetrate slightly, no more than 1", into the previous layer when rodding the second and/or third layer(s).
3. Lightly tap the sides of the cylinder with open hand (do not use rod!) 10 - 15 times between each layer and prior to strike off.
4. Strike off top surface evenly using a float, rod, or other suitable tool. Do not use cap as a finishing tool!
5. When casting of mold is completed, cylinder cap should be placed on mold immediately after finishing. Mark the S.P., field ID, and date on cylinder's side, immediately move mold to protected area - do not disturb for 24 hours.

When all testing is complete, IAI will mark results in the appropriate area on the "Certificate of Compliance" and sign on bottom - name of Mn/DOT IAI, date, who did test - get a copy if possible.

Always Remember: You as the IAI will determine if they procedurally fail and need a revisit and retest, or just have a "Mulligan(s)"....but - be consistent. You can usually tell if the person is "shaky" and "unsure" or is a newer technician that needs some additional training time to become proficient. If they seem uncertain, direct them to read up on test procedures from the appropriate training manual(s) and that it would be better for you to return another day for a revisit. After the IAI review, it would be a good idea to let the Chief Inspector and or Project Engineer on the job know if the technician needed some major "coaching" or more training and that they should probably have another experienced technician handy in the area for any future testing until the tester passes the IAI review.

Before you leave the site, be sure that you have all information you observed on this visit recorded in your diary including: any abnormal site/placement conditions; all "Mulligans", failures; anything pertinent about the material or procedure you may have told the inspector/tester; plant Q/C and Q/A personnel, etc. Upon your return to the office, log into the

IAI database and enter all information under “Concrete Contacts” – “Concrete Air Slump”. Print out one copy of the original contact, staple it to the concrete order, plant gradation sheet (if applicable) and place the packet in the job file. Make 5 copies of the new Project Summary: 1 for file, 4 for IAI folders. Replace the old Project Summary with the new updated version. If you have an “improper procedure” (failure): Immediately follow-up with an E-mail to the Project Engineer, attach your IAI report for the “improper procedure” you observed technician “X” doing on their project, and that this will now require a revisit/retest. While IAI cannot keep the technician from working, we can let the Project Engineer know that there is a tester problem on the project that needs their attention and correction, and that it will show up in our Summary Report.

We realize that in the “real” world every single test will not be textbook “perfect” every single time. Yet the technician must be able to demonstrate their ability to perform the test correctly for IAI.

We have developed these processes to try and deal with these realities - while preserving the integrity of the test and using the process as a teaching opportunity for the technician to improve their testing skill level.

We have modeled these processes after the Mn/DOT-ACI Concrete Field 1 test they originally took to get their formal 5-year certification.

The following list of “improper procedures” (failures) will require a revisit and retest if the person does any one of the following errors:

AIR	SLUMP	CYLINDER
Rods < 20 times or > 30 times	Rods < 20 times or > 30 times	Rods < 20 times or > 30 times
Rapping < 7 OR > 18 times	Rapping slump cone	Wrong # of lifts
Not doing three lifts	Not doing three lifts	Knock cylinder over after casting complete
Putting in Concrete without rapping pot	Taking downward pressure off cone at any time before final cone removal	Reusing conc. from previous and or another test
Leave petcock(s) open	Shake, vibrate, or hit coned up concrete or base board after slump cone removal	Forgetting to do any of the required steps
Leaking water at seal	Reusing conc. from previous and or another test	Not enough conc. to complete all required tests
Not releasing all air from chamber	Forgetting to do any of the required steps	
Reusing conc. from previous and/or another test	Not enough conc. to complete all required tests	
Forgetting to do any of the required steps		
Not enough conc. to complete all required tests		

If the technician performs (or doesn't perform) a test procedure infraction that does not fall into any of the above "failure" lists, it is still an incorrect procedure – but we will consider this a "Mulligan".

The following process was agreed upon and will be used for all "Mulligan" infractions - this process is to be used per each individual test procedure:

- For the first "Mulligan": Stop testing and tell them of their error - explain why they must do each step of the test procedure correctly and warn them not to commit any more. Continue the test from that point. Their test results will be considered valid - no revisit required. Document what happened and what you told the tester.
- For a second "Mulligan": Again, stop testing and tell them of their 2 errors - explain why they must do each step of the test procedure correctly and continue the test from that point... but now tell them this will require a separate IAI revisit on another day, after they have reviewed the correct test procedures and practiced - they must then demonstrate to the IAI that they can retest correctly. Their test results will still be considered valid. It would be a good idea to have another IAI present at the retest if possible.
- For a third "Mulligan": Immediately stop testing and tell them of their three errors, but now they must dump out the test and start over from the beginning with a new test, their first test results will be considered invalid (because of so many testing errors we can no longer trust the results). Now this will require a separate IAI revisit on another day, after they have reviewed the correct test procedures and practiced - they must then demonstrate to the IAI that they can retest correctly. It would be a good idea to have another IAI present at the retest if possible.

Document all "Mulligans" in your report.

The above IAST procedures are intended to be a guideline only. This will not cover every circumstance encountered performing IAI duties. Please contact your supervisor with any questions not covered under these guidelines. trs 11/20/2008