CONSTRUCTIVELY SPEAKING

US Army Corps of Engineers—Afghanistan Engineer District—

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COLLAPSIBLE SOILS

By Hahns Copeland, P.E.

Conditions in arid and semi-arid climates like Afghanistan favor the formation of the most problematic collapsible soils. The mechanisms that account for almost all naturally-occurring collapsible soil deposits are debris flows, rapid alluvial depositions, and wind-blown deposits (loess). Collapsible soils are moisture sensitive in that increase in moisture content is the primary triggering mechanism for the volume reduction of these soils. One result of development in arid regions is an increase in soil moisture content. Therefore, the impact of development-induced changes in surface and groundwater regimes on the engineering performance of moisture sensitive arid soils, including collapsible soils, becomes a critical issue for continued sustainable development into arid regions. In practicing collapsible soils engineering, geotechnical engineers are faced with:

1. Identification and characterization of collapsible soil;
2. Estimation of the extent and degree of wetting;
3. Estimation of collapse strains and collapse settlements;
4. Selection of design/mitigation alternatives.

The severity of the collapse depends on the extent of wetting, depth of the deposit and loading from the overburden weight and structure. The wetting sources typically consist of landscape irrigation, poor surface drainage resulting in ponding, utility line leakage, and intentional ponding such as detention basins and water features. Collapsible soils are soils that compact and collapse after they get wet. The soil particles are originally loosely packed and barely touch each other before moisture soaks into the ground. As water is added to the soil in quantity and moves downward, the water wets the contacts between soil particles and allows them to slip past each other to become more tightly packed. The common visible feature, attributed to the collapsible soils, were numerous "collapsecraters" varying in diameter, depth and area of coverage. We observed naturally occurring routes of downward movement of soil-loaded water. Another term for collapsible soils is "hydrocompactive soils" because they compact after water is added. The amount of collapse depends on how loosely the particles are packed originally and the thickness of the soil that becomes wetted. Collapsible soils are common in Afghanistan and have the potential to cause millions of dollars of damage to public facilities such as schools, highways, ANA facilities, ANP facilities, water tanks, water lines, sewer systems, rural roads, and many other types of infrastructure. The US service members and civilians have a duty to

Example of a Small Collapescrater

COLLAPSIBLE SOILS (cont'd)

perform good due diligence in selecting sites, investigating soil conditions, designing structures, and administering contracts, for collapsible soils can potentially impair a well conceived mission.

Collapsible soils develop on valley margins where soil particles move from the foothills toward the valleys. They commonly accumulate to thick layers that can reach depths of 40 plus meters. As USACE projects in Afghanistan are located outward from villages that may be well-watered and irrigated valleys, with compact soils, the collapsible soils have made their presence known as the new projects add water to the drier soils from increased runoff and other means. The additional water added to the naturally dry soils is caused by runoff from impervious surfaces and coupled poorly graded site drainage. New facilities can be affected by the addition of water near their foundations, into utility trenches, and other excavations.

Example of a Large Collapescrater

Site Drainage

Site Drainage is a very important factor to be considered during design and construction. Construction sites with both collapsible soils and large amounts of site grading activates require adequate rough grading during construction to control runoff. If rainfall runoff ponds throughout a site with no sediment control and runoff control, infiltration from ponding waters will induce soil failures. Isolated areas of standing water will disappeared by infiltration into the ground. The site development construction activity must incorporated substantial erosion control practices. The silt laden site was subject to a higher risk of soil erosion during construction and corresponding rain events. Silty soils are particular vulnerable to soil erosion and displacement. Rough grading should establish clear and defined drainage patterns that reflect the indicated drainage patterns proposed on the site development plans.

Evaluation of Collapse Potential

A convenient and reliable criterion to detect collapsible loess soils was produced by Gibbs and Bara on the basis of bulk density and liquid limit data. If the bulk density is such that upon saturation with water the moisture content exceeds the liquid limit (indicating that upon disturbance the soil will become liquid) the soil is identified as collapsible. The potential for collapsible soils at a specific project site is initially evaluated based on the geologic and environmental setting, and our experience in the area. This includes topographic and geologic maps that identify surficial deposits, their relative age, and potential geologic constraints. The subsurface conditions are then evaluated by exploration such as with borings. Laboratory testing is performed on the samples to evaluate their compression potential and other physical properties. The compression test consists of extruding the liner sample into the apparatus confining ring, loading it to 47.9 KPa (1,000 psf), flooding the sample and additional loading. The standard test procedure for determining collapse potential of a soil is outlined in ASTM D5333-03 Standard Test Method for Measurement of Collapse Potential of Soils. The collapse potential is defined as the change in sample height upon wetting compared to the original sample height. The magnitude of col-

Subsequent Structural Damage from Large Collaspecrater

COLLAPSIBLE SOILS (cont'd)

potential is usually rated as low, moderate or high. Other physical properties testing typically consist of natural moisture content and density, gradation, and liquid and plastic (Atterberg) limits. It has been demonstrated that the collapse potential of the soil depends on the composition, gradation, the initial water content and density, and the loading at the time of wetting. The severity of settlement and impact to structures which can result from collapse of the subsoils depends on several conditions. These include:

- Collapse potential of the subsoils;
- Depth of the collapsible soils;
- Foundation loading, configuration and depth;
- Sensitivity of structure to differential settlement;
- Site grading and drainage;

The collapse potential and depth of the problem soil are physical constraints for a given site. The foundation conditions, structure stiffness and other site improvements are design development considerations and are more controllable. Predicting settlements due to collapsible soils is difficult due to several factors including sample disturbance problems, variability of the subsoils, extent of wetting and variable loading conditions. Settlement estimates are generally made by taking the collapse potential over the potential depth of wetting. The settlements typically occur along the perimeter of the structure and are differential. Relatively severe settlements and building distress have been experienced where the collapsible soil depth is greater than about 6 meters (20 feet). Settlements up to about 300 mm and severe structural distress have been documented.

Design and Mitigation

The identification of the soil collapse and severity of settlement potential is the initial information needed for the mitigation design. The feasibility of possible mitigation methods at a given project site depend on the structure conditions and the level of risk that the project owner is willing to accept. More options will generally be available to new construction compared to existing structures where there are constraints to mitigation options. Some settlement and building distress is usually acceptable to owners of lightly loaded structures such as residences, especially when the risks are known to be common to the area. Less risk is usually acceptable where there are heavily loaded or settlement-sensitive structures where the consequences of distress warrant more effective mitigation measures. Mitigation methods can be divided into the following groups:

Structure considerations

Structure Considerations: Lightly loaded structures such as residences are usually supported on shallow spread footings. The footings should be lightly loaded with a bearing pressure of 47.9 KPa (1,000 psf) or less. The building loads should be carried mainly by heavily reinforced foundation walls in a "box-like" configuration. The foundation design should limit excess surcharge loading from deep backfills placed against foundation walls. Stiffened slabs or mat foundations could be used to further reduce differential settlement potential.

COLLAPSIBLE SOILS (cont'd)

Site Features

Site Features: Subsurface wetting from shallow sources can severely impact structures founded on shallow foundations. The foundation backfill should be adequately compacted and have positive surface drainage to prevent ponding. Gutters should be provided with drain downspouts that discharge away from the building. Landscape irrigation should be restricted and, in some cases, essentially eliminated by the use of xeriscape. Basement foundation drains should be underlain with an impervious liner to prevent water seepage below the foundation. On-site detention basins or water features should be lined with an impervious membrane.

Collapsible soil avoidance

Avoid Collapsible Soils: When the collapsible soils are shallow, they can be removed for bearing on the underlying soils or replaced and compacted to re-establish design bearing levels. Piles or piers can be used to extend the bearing level to below the collapsible soils. This alternative is typically considered where the structure is relatively heavy or settlement-sensitive and the depth to adequate bearing material is economically feasible.

Ground Modification

Ground Modification: Various ground modification methods can be used to prevent or limit collapse from occurring, or cause the collapse to occur before construction. These methods include:

A) partial removal and replacement of the collapsible soils with compacted select materials;
B) over excavation and removal to a specified depth, pre-wetting soil and re-compacting;
C) densification of the collapsible soil in-place, such as by compaction grouting or dynamic compaction;
D) pre-wetting of the collapsible soil followed by surcharge loading to cause settlement before construction. ***END***

COMMON DEFICIENCIES

ELECTRICAL

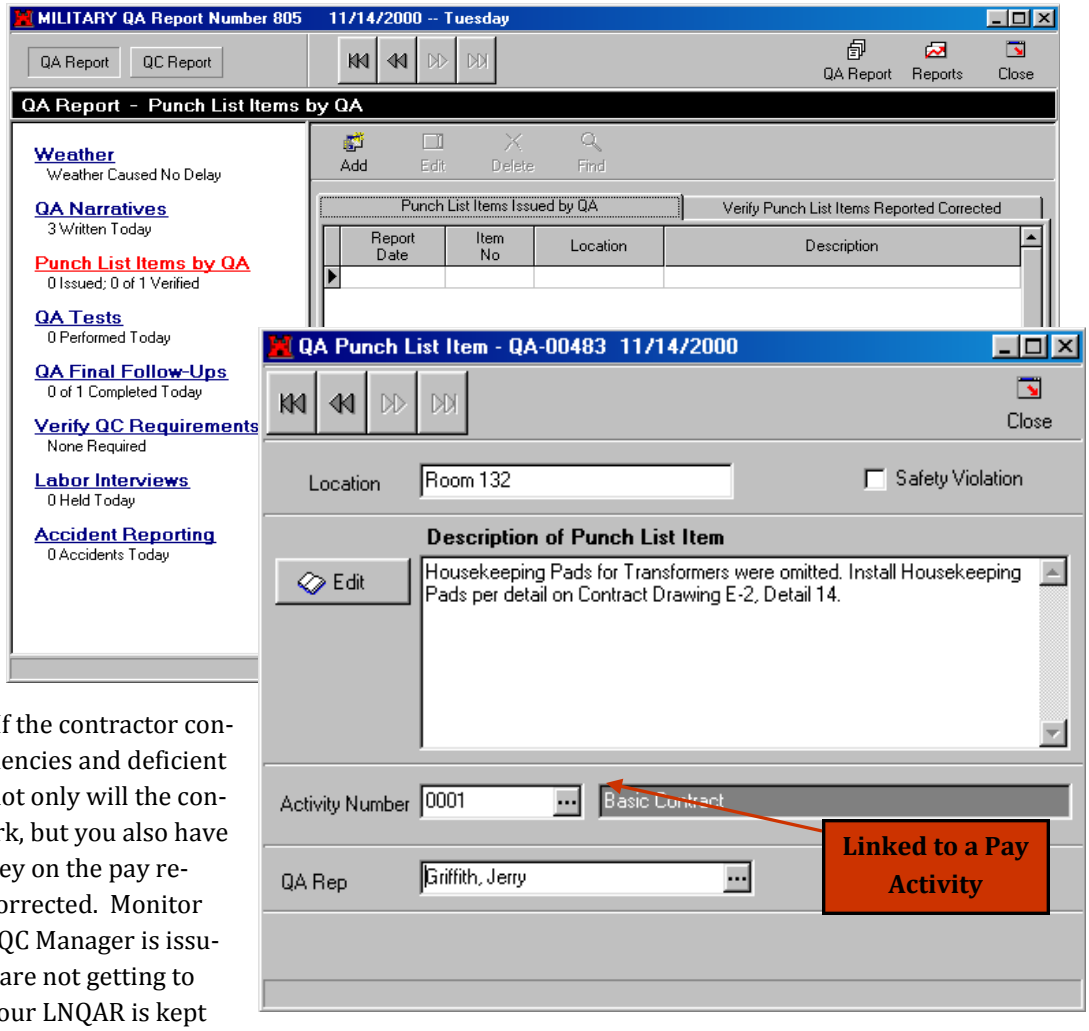
NOTE This picture shows the proper way to create a bend in electrical conduit. A smooth long radius which prevents the wire insulation from being damaged during the installation process. The wire slides around corners and will not bind on a sharp edge.

This is a sewer pipe, not an electrical conduit. The 45 degree elbow causes an abrupt and sharp transition.

Punch List Items by QA (aka Deficiency Tracking System)

By: Sandy Higgins, Quality Assurance Branch

Punch List Items by QA gives the Government a means to communicate comments to the Contractor resulting from an inspection, site visit, or various other reviews. This communication may be of a positive or negative nature. The comment can compliment the Contractor and the workforce or it can document a problem, deficiency or safety item. Using QA Comments function in RMS, the Government can draw the Contractor's attention to an overlooked item, faulty workmanship or job site conditions, to name a few. If the comment is issued as an action item, the comment is placed on a QC list to be corrected by the Contractor, reported corrected by the Contractor, and then verified by the Government. For the Contractor, the list will be found under **Punch List Items / Punch List Items by QA** on his daily report. The Government can then track the action until it is reported completed and the Government concurs that the action is completed satisfactorily. The Governments' verification of this is covered under **Verify Punch List Items Reported Corrected.**



NOTE: The ideal situation is for the Quality Control Manager to be issuing punch list items throughout the construction period. This is not something that contractors like to do for the simple fact that it appears they are not doing a good job. We must continue to remind the Quality Control Manager that this is not only part of their Quality Control Plan, but that they will be evaluated on this factor. Good deficiency tracking from the beginning will ultimately result in a better pre-final/final inspection. If the contractor consistently fails to track deficiencies and deficient work is being covered up, not only will the contractor have to tear out work, but you also have the ability to withhold money on the pay requests until the items are corrected. Monitor the QC reports to see if the QC Manager is issuing punch list items. If you are not getting to your project sites, ensure your LNQAR is kept informed and provide him with the RMS report so he can check to see if they're getting corrected. Also, if your LNQAR is documenting deficiencies on his daily reports, it is your duty to issue these in RMS as Punch List items and not just in the narratives. Whether it be the QC Manager or the QA Rep issuing the punch list items, remember to link these to pay activities so that when payment is requested on such activities, full payment will not be made until such corrections are made. Print out a report from RMS each week and discuss these items in your weekly coordination meetings with the contractor. The items will also appear on the Action Items Report generated from RMS along with the DD1354 Transfer Document if items are not corrected. For more information on how to track punch list items in RMS, see the RMS User Guide.

WATER QUALITY FOR BOILERS

Part 1: Boilers and Classification

By: Steven Baughman, P.E. Mechanical Engineer, Quality Assurance Branch

Recently I was asked to examine the requirement for water treatment for a hot water boiler here in Afghanistan. The research that went into this might be valuable, or at the very least interesting, to others out there in the field. So for those of you who might find this useful, and if you are reading this I assume it is at least an intriguing topic, please join me in this two-part article as I examine the issue of water quality, treatment of boiler water, and the effects of untreated water on boilers.

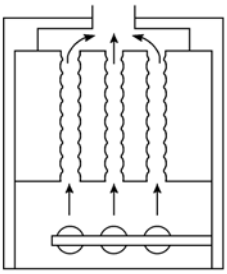
So you have a boiler? Great, I am glad to hear it. Is it a hot water boiler or a steam boiler, low pressure or high pressure, electrode, coal fire, gas fired, or oil fired, and is it a closed or open system? Let us take a look at the types of boilers and how this might affect water issues.

Boilers can be classified in many ways such as shape, size, pressure, application, and output. The American Society of Heating and Refrigeration Engineers (ASHRAE) breaks up the classification for us in Chapter 27 of their HVAC Systems and Equipment Handbook. In Chapter 27, there are five basic parameters in the classification of boilers: 1) Working Pressure and Temperature, 2) Fuel Used, 3) Construction Materials, 4) Type of Draft, and 5) Condensing or Non-condensing.

With regards to temperature and pressure, boilers can be classified as low pressure or high pressure. Low pressure boilers are those with pressures less than 15 psig (103 kPa) of steam or less than 160 psig (1100 kPa) of hot water. Hot water systems are limited to 120 degrees Celsius (250 deg F) for low pressure systems. High pressure systems are those above these limits.

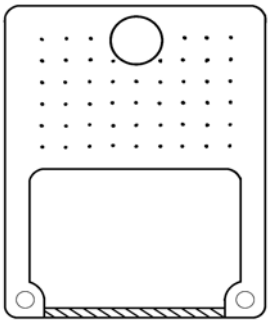
Boilers can be electrical or fuel burning. Fuel burning boilers use coal, wood, fuel oil, waste oil, or fuel gas. It is important to note that boilers should not be converted to run off of a fuel that they were not initially designed for as this changes more than just the heating of the system. It also changes the requirements for safety and construction.

Boilers can be constructed of Cast Iron, steel, copper, stainless steel, and aluminum. Boilers come in three basic construction types regardless of material: 1) Dry base, 2) wet base, and 3) wet leg. Dry base (see figure 1) systems have the combustion section separated from and under the fluid sections. Wet base systems (see figure 2) have the combustion system separated from but surrounded by the fluid sections. Wet leg systems (see figure 3) are similar to wet base systems but do not have a fluid section underneath the combustion section. Cast iron systems are made of large cast sections that



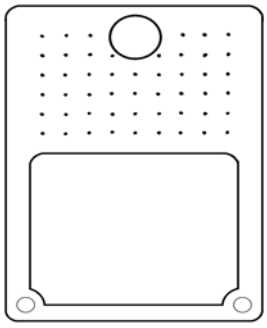
A DRY-BASE, ATMOSPHERIC GAS, VERTICAL SECTIONS

Figure 1



B WET-LEG SECTION

Figure 2



A WET-BASE SECTION

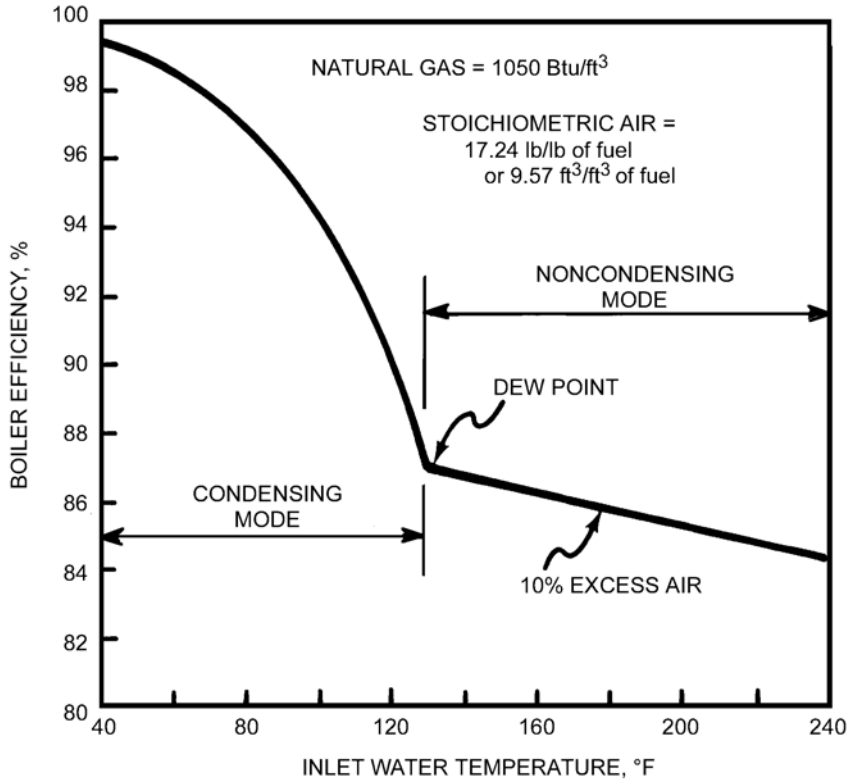
Figure 3

WATER QUALITY FOR BOILERS

Part 1: Boilers and Classification (cont'd)

separate the combustion and fluid areas. Steel, copper, and stainless systems use tube designs that are either fire tube or water tube designs. Fire tube designs submerge flue gases in tubes in the fluid medium. Water tube designs pass the flue gases around tubes that contain the fluid medium. Again, these may be of dry, wet, or wet leg construction using tubes instead of large cast sections. Aluminum boilers can be either constructed of cast sections or in tube designs. To minimize stress cracking, stainless steel boilers are limited to operating temperatures of 99 deg Celsius (210 deg F) or less.

In order to control the flue gases and move them past and around the fluid sections or tubes within the boiler, a pressure difference is required. This pressure difference is referred to as the draft. To achieve this draft, a boiler will employ either a mechanical draft or natural draft. Natural draft systems take advantage of the tendency of the flue gases to rise naturally. Mechanical draft systems employ a fan to create a pressure difference between the combustion chamber and the rest of the flue gas system. This is done by either forcing air into the combustion chamber (forced draft) or drawing air out of the combustion chamber (induced draft).



In the past boilers did not allow condensing of flue gases in the boiler. This was done to control and minimize corrosion and extend the life of the boiler. Newer systems take advantage of the higher efficiency that can be gained with lower water temperature and employ a condensing system allowing the flue gasses to condense in the boiler and drain back down. This requires corrosive resistant construction of the interior of the boiler but allows for much higher efficiencies to be obtained.

Electric boilers deserve a side not in these discussions. While they can be high or low pressure systems, they do not have combustion gases and do not have any of the concerns associated with combustion. The electric elements of the boiler are submerged directly in the fluid medium and do not employ a draft mechanism as seen in the fuel burning systems. This will be important to remember as we move forward in our discussion of boilers.

This has been a lot of information and not as detailed as one might like. Please refer to Chapter 27 of ASHRAE's HVAC Systems and Equipment Handbook for more detailed information and figures. Next time we will begin to look at how these parameters influence water treatment and how we might extend the life of our boiler.

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IMPORTANCE OF BASELINE SCHEDULES

By: Philip Di Salvi, Baker Scheduler

Schedule and costs are, in effect, the primary controls an owner has to effectively administer and control a construction contract. Accordingly, it is imperative to incorporate the two into a tool that can be systematically used to efficiently monitor and manage the project.

By incorporating proven specifications into the contract that require the contractor to prepare and submit a cost and resource loaded schedule, and developing the payment application forms using Primavera software, the owner is virtually assured of receiving acceptable periodic schedule updates in a timely manner.

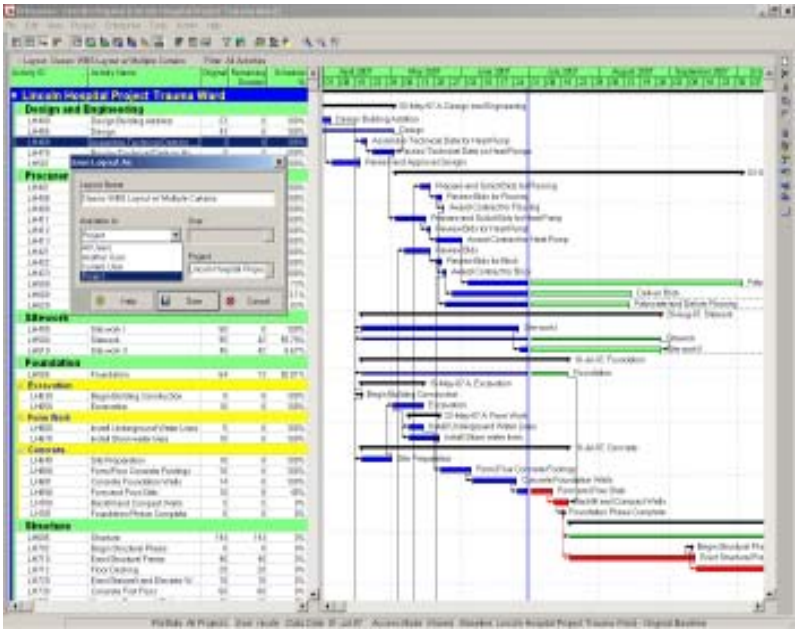
Every project manager's goal is to deliver each project on time and within budget. Using a cost and resource loaded project schedule is an integral component in support of that goal. A quality project schedule provides a tool by which the project can be planned and monitored. Moreover, utilizing the cost and resource loaded schedule, changes to the contract can be assessed for both resource requirements and time impact. Time impact evaluations and recovery plans can be developed using the schedule such that time impacts resultant of changes in work scope can be effectively mitigated.

Project success is often contingent on the quality of the contractor's baseline schedule. Keeping this in mind, it is imperative to effectively analyze the initial baseline schedule submission for, among other items, contract compliance, thoroughness and level of detail of the work plan, correct work sequence, and activity logic.

It is important that the project manager and scheduler review the contractor's baseline schedule sufficiently to ward off schedule traps.

The baseline schedule should contain only one clear critical path from beginning to the end of the project.

The use of experienced project controls professionals has become a necessity to the success for any construction effort and in the overall scope of effort, is money well spent.



The following items are to be considered when reviewing baseline schedules:

* Duration of submittal review activities for compliance with the contract

*Procurement, fabrication and delivery activities should be independently identified

*Early project completion dates may provide for a delay claim

*Watch for use of preferential logic

- *Preferential logic is the application of logic between work activities that does not constitute absolute logic and can be manipulated by the contractor to hide float.
- *Preferential milestones – the owner recognizes only contract milestones
- *Preferential logic causing criticality which eats up available float

*Sequestering of float

- *Preferential sequestering
- *Artificial activity durations

*Failure to include testing activities

*Multiple critical paths

*A critical path using logic leads and/or lags

*Identify percentage of near critical activities (between 1 & 5 days float)

- *No more than 20% of activities should be shown as near critical

*Identify percentage of critical activities (zero float)

- *No more than 15% of activities should be shown as critical

If you have any questions regarding this topic, please contact the Baker Group via email TAN.BAKER.GROUP@USACE.ARMY.MIL, or stop by the Azadi Office in the Qalaa House Compound in Kabul. Baker is providing construction management support services in the areas of scheduling, RMS, and database management and will provide more information about these services upon request.