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Using Installation Work Packages (IWPs) To Produce Detailed and Accurate Estimates

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Abstract

Construction cost estimates predict future costs as result of taking on a specific construction endeavor. Having a comprehensive understanding of work to perform is not only a minimum prerequisite during estimate development, it is a leading contributor to estimate accuracy. An effective approach to enhance the quality of an estimate can be achieved through review of the installation work package (IWP). A thorough review of the IWP allows the estimator(s) to conceptualize the intricacies of the work scope. This paper explains how conceptualizing the planned construction work through IWP review strengthens the estimator's understanding of construction work nuances and unleashes enhanced estimate detail and accuracy.

Although construction cost estimates are a prediction of forecasted costs, estimates are sometimes found to be within acceptable range of later-received contractor bid amounts. Despite this, construction cost estimates are not a guarantee of, nor synonymous with, actual costs incurred and therefore, forecasted cost and actual cost concepts should never be conflated. Whether one is an entry-level estimator or one with more than 10 years of experience, this technical paper will provide guidance on how to apply effective techniques in the development of high-quality estimates.

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1. Introduction

In its Recommended Practice (RP) 46R-11, Required Skills and Knowledge of Cost Estimating (RP-46R-11), the Association for the Advancement of Cost Engineering International (AACE), defines estimating as "a predictive process which requires judgement and experience." [1] AACE continues to explain that "some aspects of estimating lend themselves to semi-automation (e.g. quantity take-off tools, estimating software, determinations of quantities by computer-aided design tools, and so on)," and that "while these tools increase efficiency they are not a substitute for experience and judgement." [1]

Understanding the work to be performed is vital to the overall outcome of the estimating process. Further affirming this notion, that same RP also states that "effective cost estimating requires an understanding of the work being planned." [1] The Construction Owners Association of Alberta's (COAA) workface planning (WFP) framework, a framework also termed by the Construction Industry Institute (CII) as advanced work packaging (AWP), defines IWPs as the deliverable that enables a construction work crew to perform work in a safe, predictable, measurable, and efficient manner. [2] An estimator can attain greater understanding of the tasks involved, sequencing, and nuances of the planned construction work by review of the applicable IWP. This kind of review strengthens and/or supplements the estimator's *experience*, *judgment*, and *understanding of the work being planned*, and leads to enhanced estimate detail and accuracy.

1.1. The Estimating Process

A cost estimate is "a compilation of all the probable costs of the elements of a project or effort included within an agreed upon scope." [1] Estimating involves applying construction experience and knowledge to a defined and specific evaluation process, the estimating process. This produces an approximation of the potential or "probable" cost of that work. At a minimum, the estimating process includes seven (7) steps: [1]

1. Planning for the estimate,
2. quantifying the scope (quantity take-off),
3. applying cost to the scope (costing),
4. pricing the project (pricing),
5. reviewing,
6. validating, and
7. documenting the estimate.

As can be seen above, costing and pricing are separate steps. This is because costing and pricing are not synonymous in definition. AACE distinguishes that "pricing includes cost adjustment techniques that various stakeholders in the plan (bidders, contractors, etc.) apply to costs in the estimate to allow for overhead and profit, to improve cash flow, or to otherwise address market conditions and serve their business interests. It is important to distinguish between costs and prices." [3] AACE further distinguishes that "costing does not consider business concerns of how work is to be charged, billed, marked up, or otherwise accounted for by various stakeholders." [3]

It is important to consider the end-use of any estimate during its development. Estimates are used for feasibility studies, value engineering workshops, budget-authorization decision making, and change management, to name a few. The estimate class (estimate type) that would correspond in each end-use varies. Some estimate types are less detailed, while others are more detailed. These variations are primarily based on the project's scope definition (project maturity) and phase of the project, as at the time of development. As can be seen in Table 1, a Class 1 estimate is developed when the project definition is advanced to between 65 – 100%.

	Primary Characteristic	*Secondary Characteristic*		
ESTIMATE CLASS	**MATURITY LEVEL OF PROJECT DEFINITION DELIVERABLES** Expressed as % of complete definition	**END USAGE** Typical purpose of estimate	**METHODOLOGY** Typical estimating method	**EXPECTED ACCURACY RANGE** Typical variation in low and high ranges at an 80% confidence interval
Class 5	0% to 2%	Concept screening	Capacity factored, parametric models, judgment, or analogy	L: -20% to -50% H: +30% to +100%
Class 4	1% to 15%	Study or feasibility	Equipment factored or parametric models	L: -15% to -30% H: +20% to +50%
Class 3	10% to 40%	Budget authorization or control	Semi-detailed unit costs with assembly level line items	L: -10% to -20% H: +10% to +30%
Class 2	30% to 75%	Control or bid/tender	Detailed unit cost with forced detailed take-off	L: -5% to -15% H: +5% to +20%
Class 1	65% to 100%	Check estimate or bid/tender	Detailed unit cost with detailed take-off	L: -3% to -10% H: +3% to +15%

Table 1 – AACE RP 18R-97 – Table 1 Cost Estimate Classification Matrix for Process Industries [4]

AACE defines a Class 1 estimate by two overarching categories. The first characteristic is maturity-level of project deliverables. [4] The next characteristic encompasses both the estimate end-usage and the estimating methodology. A Class 1 estimate's estimating methodology is "detailed unit cost with detailed take-off." [4] In RP 101R-19, Roles and Responsibilities of a Cost Estimating Practitioner, AACE illustrates how, oftentimes, an entry-level estimator has 1-2 years of construction experience, while a mid-level or senior-level estimator typically has 2-5 or 7-10 years of construction experience, respectively. [5] These ranges are not only a synopsis for years of practice, but moreover, are intended to expresses the level of experience, judgement, and knowledge that a person at each respective level potentially possess. Although estimating activities such as quantity take-off and costing may be doable for an estimator at any level, beyond the mere execution of these activities, experience and judgment is a contributing factor.

Further, that experience and judgment must be applied. To emerge and materialize any estimator's judgment, experience, and construction knowledge, reviewing the IWP can support or strengthen an estimator's conceptualization of the work to be performed. This paper focuses on applying IWP review and the emerged conceptualization to the quantity- take-off and costing steps of the estimating process to develop a high-quality Class 1 direct construction cost estimate.[1]

2. Origins of AWP

The 1990s are considered by COAA to be the beginning of the WFP framework [6]. COAA formed a WFP committee in 2006, and that same year published its first WFP model [6]. By 2012, CII, an industry research and development platform based out of The University of Texas at Austin, and the COAA established a partnership [2]. The outgrowth of that partnership was that "CII and COAA researchers developed a series of recommendations and best practices for work packaging techniques that include detailed front-end planning and enhanced construction execution planning and management" [2]. In COAA's Advanced Work Packaging / WorkFace Planning Best Practices Guideline, COAA states that "the concept of Advanced Work Packaging (or AWP) is a series of processes intended to improve construction performance from concept to commissioning, very much like the intended effects and scope of WorkFace Planning" [2].

[1] This paper is not intended to be a literary guide in the practice of estimating; therefore, it does not include or recommend preferred mathematical algorithms for value inputs and outputs, nor does it recommend tools, databases, or software platforms.

Importantly, COAA asserted that AWP is "most relevant to the field-level execution (construction) stage of the project" [2]. An essential aspect of the overall AWP framework is the IWP, a deliverable that enables a construction work crew to perform work in a safe, predictable, measurable, and efficient manner [7]. The information included in thoroughly completed IWPs typically reflects a clear understanding of the work to be performed, which will be demonstrated by the information and level of detail included therein. Figure 1 below illustrates the AWP model and highlights where IWPs fit within the overall process.

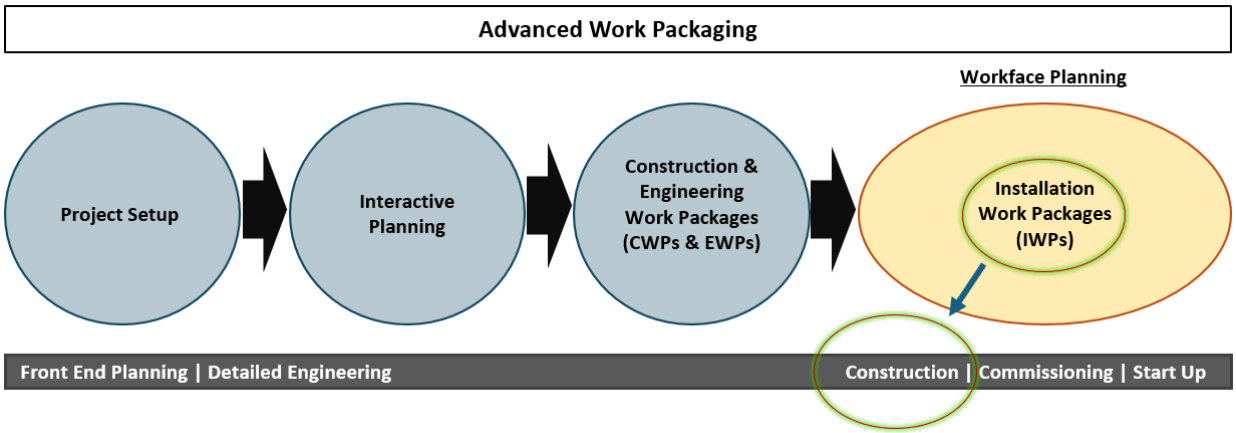

Figure 1 – Reproduced and revamped COAA AWP Model, With "Construction" Phase Highlighted Under IWP Process [2]

The following sections will discuss parts of both an IWP and an estimate, in order to illustrate how those parts correlate with each other, and how parts of the IWP can strengthen or support the estimator's understanding or conceptualization of the work.

3. Facets of IWPs As Compared to Common Estimates

As shown above, the IWP is a subpart of the overall AWP process framework. In summation, the IWP often includes:

- description of work scope,
- sequence of major activities,
- environmental, health, and safety (EH&S) information,
- equipment detail,
- materials, tools, and consumables,
- manufacturer's installation instructions,
- model shots,
- quality control (QC) and quality assurance (QA) information,
- as-built documentation,
- coordination with other trades, and
- technical documentation, including drawings and specifications.

Published by COAA from its digital library, the following information is a completed example IWP for a piping scope of work (Completed Piping IWP) [8]. It is reproduced below for convenience. These figures depict the information contained in an IWP and how that information might be organized.

1. Scope:

Install, fit and weld 24” carbon steel large bore piping from pump P-5304 discharge flange to Vessel C2112 inlet flange. The tower is 60’ tall and the inlet flange is located at the top of the tower with a service platform 2’ below. The pump is located 50’ SE to the tower, the piping is elevated to 12 feet above grade and running west and north to south side of the tower and up to the nozzle.
The piping is fabricated into 3 spools A, B & C and requires 2 field welds after installation. The piping has two free standing pipe supports at grade and 2 located on the side of the tower.
Estimate spool length spool “A” is 50’ long, spool “B” is 30’ and spool “C” is 40’ plus.

2. Deliverable:

•Pipe supports materials, pipe spools, gaskets and hardware material for work commencing on Oct 10-12.
•-Required an 80-ton crane for spool erection and a 30 ton for tailing and pipe support installation.
•-Scaffold must be in place prior to work commencing.

3. Activities:

3a. Sequence of spools installation from tower to pump

•Erect scaffolds at pipe support and field joints for access. Leave temporary access for spool installation.
•Piping crew to verify piping materials, gasket and hardware, spool dimensions, check for shipping damage, and prepare for installation.
•Transport material and spools from lay down yard to installation site.
•Install pipe supports, once installed surveyor to verify elevation
•Setup 80t crane east of tower and lay spool north of crane running east/west with tower connection on west side. And setup tailing 30t crane on tail end of spool.
•Prepare rigging material, verify sling sizes and length, check for damage.
•Lift and install spool “A” from tower inlet flange down using an 80 ton for the main lift and 30t for tailing. Secure spool with two tower supports.
•Install spool “B” on pipe support and temporary fit and secure to spool “A”.
•Install spool “C” temporary bolt to pump discharge flange and secure to pipe support.
•Review attached welding procedure and verify welding rods.
•Align pipe flange to pump discharge, fit and weld two joints with QC inspection and approval of welding.
•NDE joints.
•Bolt up crew to check bolt tension on flanges and pipe support.
•Dismantle scaffolds.
•Daily progress report.

Figure 2 – COAA Completed IWP Example for Piping Scope of Work, Pages 2 - 3 [8]

4. Resources

4a. Equipment

•80T mobile crane for spool installation and a 30t for tailing and install pipe supports.

•One Rectifier welding machine; rod oven.

•One set of Surveyor equipment.

4b. Tools

•Rigging wire slings and shackles,

•Oxy/Accet. cutting outfit, welding lead; hand grinders; rasp file; 1 7/8" combination wrenches, 1 7/8" torque wrench and pipe fitter hand tools.

4c. Materials

•Pipe support materials and 3 spools at lay down yard.

•Hardware and gaskets are bagged and tagged at warehouse.

•Welding rods are in tool crib in welding rod's oven.

•Scaffolding material.

4d. Labour

•1 – Scaffold F/M 3 Scaffolders and 1 labour.

•1 – Piping foreman; 3 p/f riggers, I fitter, 1B-pressure welders and 1 apprentice.

4e. Work Instructions

•All crane operators must have project certification. Welders must be tested on site.

•Setup red flagging and clear rigging area; complete SPA before work proceeds.

•Setup welding hoarding or screens and sparks containment and covers up equipment below.

•Maintain a fire watch when welding and cutting.

•Coordinate with other craft and Forman working around the same area.

4f. Safety Equipment

•Barricade tape; fire extinguishers; safety harness; respirators and smoke removal.

4g. Drawings

•Piping Isometric

- o53-LP-2110-CS-111 sheet 1 Rev 3
- o53-LP-2110-CS-111 sheet 2 Rev 3

•Spool Drawing

- o53-LP -0211-CS- A
- o53-LP -0211-CS- B

4h. Vendor Information

Piping fabricator to provide piping cut sheets & inform of any RFIs, changes or materials are outstanding.

4i. Special Conditions

heights' safety standard. Exercise and stretch in the morning before climbing the tower. Apprentice must be teamed with a journeyman.

Figure 3 – COAA Completed IWP Example for Piping Scope of Work, Page 3 - 5 [8]

5. Quality Control •All bolts are to be torque to project spec 2111-ST-S2 rev 1. Spec is attached. •Welding inspector to check on welder periodically and verify correct welding rods. •Notify Willy Engineer for a spot check on bolt tensioning.
6. Interdependencies This work package is dependent on the availability an 80T cranes which are currently being used by Ironworker installing structural steel. One week prior to start of work confirm the availability of the crane.
7. Risk Planning •Do a hazard analysis before rigging spool to connect to top of tower. •Conduct pre lift meeting with crew directly prior to lift occurring.
8. Reverse Punch List (Error Proofing) •We have recently experienced some quality issues. Wrong gasket material was deliver to site for installation at pump's discharge flange. •Have experienced fitter verify the gasket material again drawing's material list before installation and inform Forman Dale if any discrepancies.
9. Lessons Learned Warehouse personnel must verify all material before deliver to site for installation.

Figure 4 – COAA Completed IWP Example for Piping Scope of Work, Page 5 - 6 [8]

Table 2 is a Class 3 estimate (Estimate #1). It is based on the scope description provided in the Completed Piping IWP example. It meets the definition's requirements of any estimate, in that it "includes the probable costs within an agreed upon scope [1]." It also meets the requirements of a Class 3 estimate because its methodology is "semi-detailed unit cost with assembly level line items" and could be used for "budget authorization or control [4]."

#	Line Item Description	Qty	Unit	Labor & Equip. Cost	Line Item's Material Cost	Line Item Total Unit Cost
1	Construction aids 5% of direct work scope	1	EA	$ -	$ -	$ 8,340
2	Piping Spools A, B, C, and Crane	120	LF	106,824	59,978	166,801
				$ 106,824	**$ 59,978**	**$ 175,142**

Table 2 – Estimate #1 – Example Class 3 Estimate

Another version of the Estimate #1 is reproduced below, advanced to a Class 1 estimate (Estimate #2). It communicates the volume, detail, and nature of information to be expected in a Class 1 estimate – manhours, detailed quantity numbers, and cost per unit for categories of material, labor, and equipment.

#	Line Item Description	Qty	Unit	MHs	Labor Unit Cost	Line Item's Labor Costs	Equip. Unit Cost	Line Item's Equip. Cost	Mat'l Unit Cost	Line Item's Material Cost	Line Item Total Unit Cost	Line Item Total Cost
1	Piping installation Set Up	1	EA	15.0	$ 6,971	$ 6,971	$ 705	$ 705	$ 710	$ 710	$ 8,386	$ 8,386
2	Piping installation Spool A and Crane	50	LF	41.0	381	19,054	578	28,915	500	24,991	1,459	72,960
3	Piping installation Spool B and Crane	30	LF	18.0	279	8,365	423	12,695	452	13,545	1,153	34,605
4	Piping installation Spool C and Crane	40	LF	29.0	337	13,477	511	20,452	481	19,233	1,329	53,162
5	Scaffolding	1	EA	18.0	3,004	3,004	12,695	12,695	7,781	7,781	23,479	23,479
6	Pipe Welding	1	EA	144.0	25,923	25,923	2,174	2,174	6,803	6,803	34,901	34,901
						$ 76,795		**$ 77,636**		**$ 73,063**		**$ 227,494**

** This estimate is an example only. Cost information depicted is for illustration purposes only.*

Table 3 – Estimate #2 – Example Class 1 Estimate

The total costs between Estimate #1 and Estimate #2 are different. This is primarily driven by:

1. the segregation of material, labor, and equipment (whereas prior, equipment and labor were combined),
2. the omission of assembly-level unit cost replaced with detailed unit cost,
3. the addition of specific manhours per line item, and
4. the added detail for construction aids, such as scaffolding in lieu of percentage-based estimating.

Also, observe the line-item description enhancements between Estimate #1 and Estime #2. The Estimate #1 line item descriptions are all nouns. Comparatively, the Estimate #2 line item descriptions are verb-noun combinations. Notwithstanding these observations, although Estimate #2 meets scorecard rating for being a Class 1 estimate because it potentially is based on mature project deliverables and a detailed quantity take-off estimating methodology, it still falls short of being high-quality. In general, this is due to the following reasons. Estimate #2 does not:

- Convey major sequences of work,
- Include details about construction aids or equipment,
- Provide details of intentional crew selections,
- Take into consideration field installation conditions,
- Consider necessary safety measures.

The Completed Piping IWP does communicate this. If Estimate #2 included these aspects, it would convey a clear understanding of the planned work.

4. Using a Completed IWP to Strengthen a Class 1 Estimate

Using the full extent of practical information provided in the Completed Piping IWP, not just the scope, Estimate #2 is enhanced and depicted below in Table 4 (Estimate #3).

#	Line Item Description	Qty	Unit	MHs	Crew Selection	Labor Unit Cost	Line Item's Labor Costs	Equip. Unit Cost	Line Item's Equip. Cost	Mat'l Unit Cost	Line Item's Material Cost	Line Item Total Unit Cost	Line Item Total Cost
1	Transport Piping; Laydown Yard to Installation Site	3	EA	3.0	Crew 1	$ 465	$ 1,394	$ 705	$ 2,116	$ -	$ -	$ 1,170	$ 3,510
2	Install and fit up; 24" Piping, Spool A, vertical, 30 & 80T Crane	50	LF	36.0	Crew 1	335	16,731	508	25,389	452	22,575	1,294	64,695
3	Connect to Vertical Pipe Supports; 24" Piping, Spool A, 60' elevated, 30 & 80T Crane	2	EA	18.0	Crew 1	4,183	8,365	6,347	12,695	452	903	10,981	21,963
4	Install and Fit-Up; 24" Piping, Spool B, horizontal, 12' elevated, 30 & 80T Crane	30	LF	18.0	Crew 1	279	8,365	423	12,695	452	13,545	1,153	34,605
5	Install and Fit-Up; 24" Piping, Spool C, horizontal, 12' elevated, 30 & 80T Crane	40	LF	27.0	Crew 1	314	12,548	476	19,042	452	18,060	1,241	49,650
6	Welding Carbon Steel Pipe, incl. Rectifier Machine	2	EA	72.0	Crew 2	6,481	12,961	544	1,087	1,776	3,553	8,801	17,601
7	Bolt-Up Spool A Inlet	1	EA	4.0	Crew 1	1,895	1,895	2,821	2,821	1,513	1,513	6,228	6,228
8	Bolt-Up Spool C Pump Discharge	1	EA	2.0	Crew 1	929	929	1,411	1,411	1,173	1,173	3,513	3,513
9	Secure Spools B and C to Pipe Support	2	EA	5.5	Crew 1	1,278	2,556	1,939	3,879	-	-	3,217	6,435
10	Install and Dismantle Scaffolding	1	EA	16.0	Crew 3	2,670	2,670	-	-	5,201	5,201	7,871	7,871
11	Surveying; Piping Centerline and Elevation	1	EA	8.0	Welder	924	924	-	-	-	-	924	924
12	Fit-Up Verifiaction; Piping, Gaskets, Hardware, Dimensions	3	EA	4.0	Fitter	122	365	-	-	-	-	122	365
13	Welding Inspection	1	EA	72.0	Crew 2a	15,707	15,707	3,263	3,263	-	-	18,970	18,970
14	Rigging Set-Up; Material, Slings, Shackles, and Dunnage	1	EA	2.0	Crew 1	929	929	1,411	1,411	2,554	2,554	4,894	4,894
15	Weld Rod Oven Rental	1	EA	0.0	n/a	-	-	1,858	1,858	-	-	1,858	1,858
16	Oxy/Accet. For Cutting Metal	1	EA	0.0	Crew 2a	-	-	-	-	3,274	3,274	3,274	3,274
17	Safety Barricading and Smoke Removal	1	EA	0.0	n/a	-	-	1,453	1,453	761	761	2,215	2,215
							$ 86,341		$ 89,118		$ 73,112		$ 248,570

** This estimate is an example only. Cost information depicted is for illustration purposes only.*

Table 4 – Estimate #3, Class 1 Estimate Piping Using IWP to Enhance Estimate Quality

To advance Estimate #2 to Estimate #3, there are two (2) overall steps. These steps, in order of application, are:

1. Conceptualization (understanding) (Step #1), and
2. Materialization (documenting that understanding) (Step #2).

Step #1 must occur to the extent the estimator understands:

1. (as an initial matter) the engineering design,
2. by extension of the first, the physical installation of the work, including
    a. major activities,
        i. sub-activities, also known as means and methods,
    b. major sequences of work,
        i. sub-sequences, and
3. physical nuances, intricacies or constraints of the work.

Next, based on a gleaned understanding derived from review of the IWP, Step #2 involves documenting the estimator's understanding of points (and sub-points) 2a through 3 outlined above. This should be performed in alignment with the quantity take-off and costing step of the estimating process.

A Class 1 estimate may not be high-quality if it only conveys the estimator's understanding of the physical installation's major activities and major sequences yet omits an understanding of the engineering design, means and methods, and physical intricacies or constraints of the work. If the estimate omits these aspects, the estimate may be limited in its beneficial end-use. Estimate #3 includes a finer degree of detail by including means and methods, sub-sequences, and construction intricacies. In practical terms, the enhancement from Estimate #2 to Estimate #3, was generally achieved through a documented understanding of:

1. activities and sequence of work
2. equipment details,
3. material specifics,
4. labor/craft needs, and
5. safety and risk (hazard) elements.

The five (5) inclusions above were derived from sections 1 and 3, 4a, 4c, 4d, and 4f and 4i, of the Completed Piping IWP. The following will discuss, at a summary level, these five (5) inclusions and how they can be incorporated into the estimate by an estimator.

5. Example Inclusions from the IWP to Consider for an Enhanced Estimate

1. Activities and Sequence of Work (IWP sections 1 and 3) – Comparing Estimate #2 to #3, an enhanced understanding of the work activities can be seen through a comparison of line items #1 through #4 in Estimate #2 to line items #1 through #11 of Estimate #3. As compared to Estimate #2, which only included general installation activities of Piping Spools A, B, and C, Estimate #3 communicates details about sub-activities and intricacies such as elevation differences (60' and 12'), details concerning horizontal or vertical installation, and the choreography of work and material from piping laydown location to installation location. Further, Estimate #3 includes considerations for pre and post elevation surveying, all as proposed in the IWP.

2. Equipment Details (IWP section 4a) – Estimate #2 includes crane cost and within its general description of line items #2 through #4. Despite this, it does not specify details about the equipment (tonnage), nor does it capture how the equipment will be used. Estimate #2 includes cost for only one (1) crane but, in this comparison, Estimate #3 includes two (2) cranes, necessary for tailing, as described in the IWP. Without understanding the intricacies of the work and equipment needs and/or a thorough review of the IWP, this could be a missing detail. However often, field conditions limit the type or quantity of equipment allowable for an activity. This type of consideration, which is communicated through the Completed Piping IWP, is captured in Estimate #3.

3. Material Specifics (IWP section 4c) – As more information is known about a specific material, a more accurate and/or detailed estimation can be approximated or quoted. The granularity of material information provided in the Completed Piping IWP discloses details about the piping, such as its related gaskets and bolts. This allows for a more finite estimation of the material and needed labor time to install that material, sub-sequences, and options for means and methods. Further, a review of the Completed Piping IWP specifies consumables (such as oxygen and acetylene), which are necessary to complete the work.

4. Labor Needs (IWP section 4d) – Certain activity-dependent and project-dependent activities require labor with specific ability (trade) and/or certification. The combination of different trades and the quantity of each must be considered. The Completed Piping IWP provides this information. The IWP designates the

need for a piping foreman, pressure welder, and an apprentice. It also designates the need for three (3) riggers and the quantity of scaffolding erectors expected.

5. Safety and Risk Considerations (IWP sections 4f and 4i) – In the Completed Piping IWP, it includes safety equipment such as harnesses, respirators, barricades, and smoke removal. The inclusion of harnesses is an extension of the detail provided in the IWP pertaining to spool elevation. The Risk Planning section of the IWP discloses information about the hazards associated with the rigging the spools. From this, it could be implied that there are intricacies associated with this work that may affect installation time due to the movement of both cranes. This type of consideration should be understood by the estimator. Notably, this consideration is included in the Completed Piping IWP.

6. Other Considerations

As explained, referencing information included in the IWP can support or supplement the estimator's conceptualization of the planned work. The IWP is typically developed with input from the construction superintendent and the workface planning lead. This is meaningful because the construction superintendent and/or the workface planning lead may bring insights to the construction sequence as well as the means and methods that otherwise may be missed by the estimator.

As set out at the beginning, the estimating process has seven (7) steps [1]. Once the estimator arrives at step five (5), reviewing the estimate [1], the estimator typically includes a consideration and review of the factors or adjustments to the estimate that are outside of the mathematical algorithm or input/output process. AACEI states, "basic estimating algorithms are often adjusted by the application of factors to make the result match the current estimate situation. Factors, as drawn from project history or a standard database, almost always reflect conditions from past experience that do not necessarily match those in the current estimate situation [3]." These adjustments or factors may include weather, geographic location, market conditions, jobsite conditions, and the like. Reviewing the estimate is important because the estimator must contemplate external influences for the purpose of making the estimate a realistic reflection of the current project variables.

7. Conclusion

Today's built environment is vast. Critical infrastructure includes roadways, bridges, tunnels, buildings, public works, and power generation, to name a few. Typically, "most cost estimators begin as junior estimators with a limited focus depending upon the industry in which they are employed [1]." This sometimes creates a limited perspective in the estimator's familiarity with construction types and by extension, their estimating capabilities.

To widen their perspectives, knowledge can be gained by working with experienced team members like the workface planning lead or construction superintendent and documenting that knowledge, such as the process of completing and/or reviewing an IWP. Estimators are encouraged to work alongside other engineering and construction professionals to provide valuable input to each step of the estimating process.

The level of effort required to develop a Class 1 estimate may not be necessary nor prudent for the entire project for a variety of reasons. AACE RP 18R-97 states that "Class 1 estimates are generally prepared for discrete parts or sections of the total project rather than generating this level of detail for the entire project [4]." There are alternative methods of predicting future expected costs, such as earned value assessments and risk analyses. In view of the size and complexity of the project, these alternative methods for predicting future expected costs should be considered. Understanding the five (5) IWP inclusions discussed above and those that are similar, and how to apply those inclusions to the estimating process can increase the detail and accuracy of an estimate.

References

[1] AACE International, Recommended Practice No. 46R-11 Required Skills and Knowledge of Cost Estimating, Morgantown, WV: AACE International, Rev. August 7, 2020.

[2] Construction Owners Association of Alberta (COAA), "Advanced Work Packaging / WorkFace Planning, A Best Practices Guideline," Construction Owners Association of Alberta, Edmonton, Alberta, Version 1.0, July 2016.

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