TETRA TECH

Where FCI Falls Short, a case study with Army National Guard

Presenter:

Michelle Mehnert

August 9, 2023

Meet Our Team

TETRA TECH

Project Manager and Civil Engineer
Michelle Mehnert PE, PMP

Director, Asset Management Program
Colby Hoefar CFM, LEED AP

Project Manager and Senior Architect
Jacene Phillips AIA, RA

Tetra Tech's

FCA Program

14 Years of BUILDER Program Experience

- ☑ CRADA
- ☑ PLA
- ☑ CERL

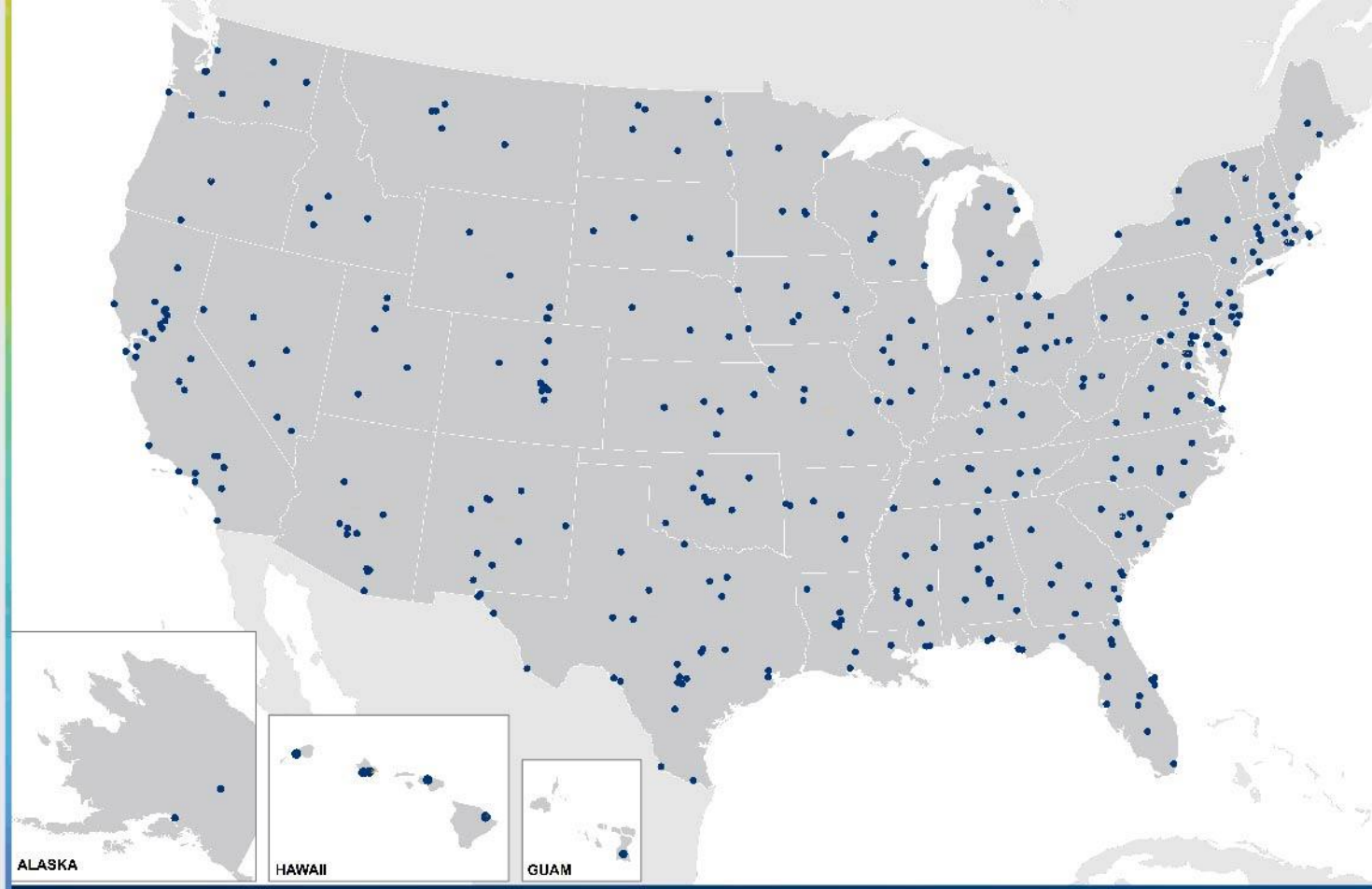
158 BUILDER Contracts

17 Average Years of Tetra Tech Assessor Experience with diverse backgrounds in:

- ☑ *Architects*
- ☑ *Engineers*
- ☑ *Facility Managers*
- ☑ *GIS Technicians*
- ☑ *Building Inspectors*
- ☑ *General Contractors*
- ☑ *Tradespeople*
- ☑ *Veterans*

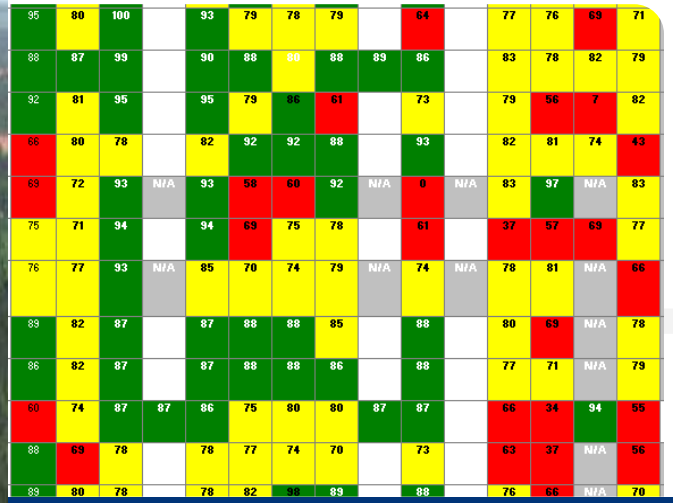
15 Recent BUILDER Clients

1. *Army*
2. *Army National Guard*
3. *Air Force/Space Force*
4. *Air National Guard*
5. *Coast Guard*
6. *Secret Service*
7. *Virginia Port Authority*
8. *Bureau of Indian Education*
9. *Federal Emergency Management Agency*
10. *K-12 Schools*
11. *City of Colorado Springs*
12. *Navy*
13. *NW Seaport Alliance*
14. *Department of Veterans Affairs*
15. *Defense Logistics Agency*



400+ Million

Square Feet Assessed



TETRA TECH

Section 1

What's in a Number?

Problem Statement:

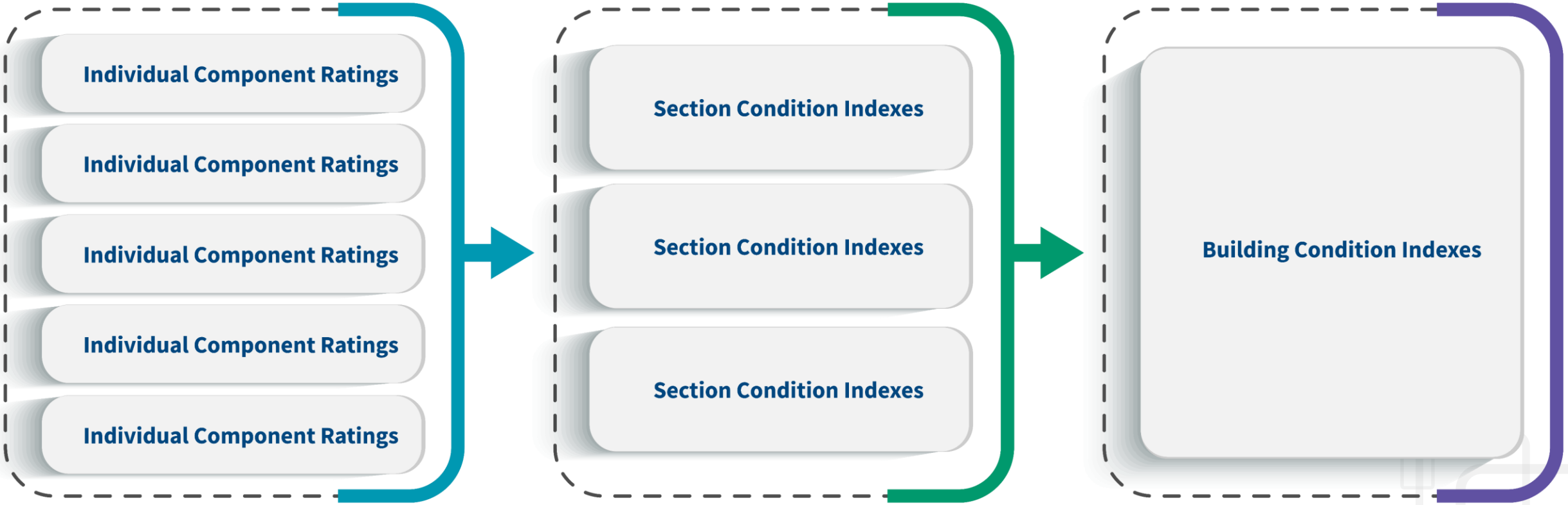
When choosing a building metric to show, which metric best reflects the lived condition & usability of the facility?

Facility Condition Index (FCI) values, while similar to ISR-Q ratings, can misrepresent the building's condition. Run-to-failure items or critical sections that affect other components can exacerbate this shortfall.

Key Vocabulary

- **Section** - The key assets in a BUILDER inventory. Building Sections represent the physical items of a Building. This is the level where ratings can be added by assessors
- **SCI** – System Condition Index, Weighted Average Condition Index for section (Weighted based on Cost)
- **RSL** – Remaining Service Life, as set by BUILDER Program
- **PRV** – Plant Replacement Value, Replacement cost of a building as estimated by HQIIS
- **Run-to-Failure** - Sections in BUILDER that do not generate repair or replacement work items regardless of condition or rating

BUILDER Ratings



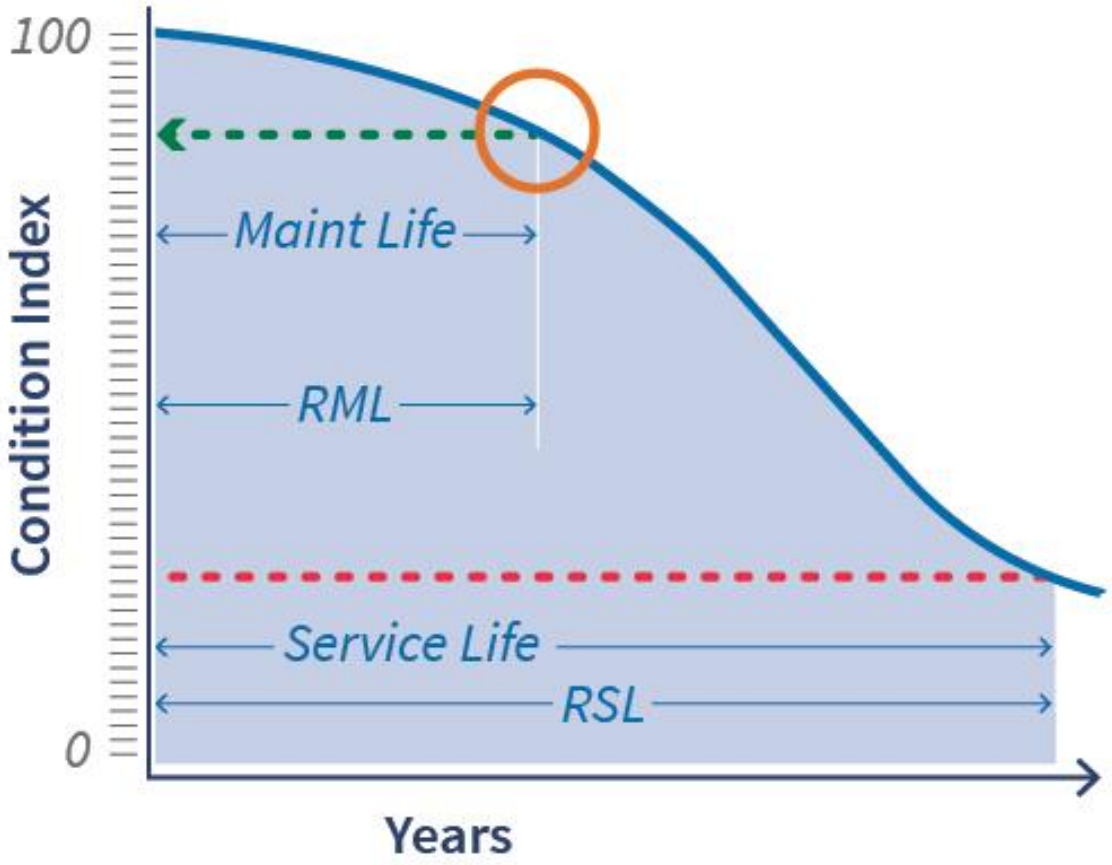
BUILDER Ratings – Individual Components

- Visual assessment based on Command specific guidance.
- Main Rules:
  - Maintainability and obsolescence should not be the driving factor in a condition assessment; unless it has led to actual deterioration of condition that can be observed.
  - Ratings are based upon the observable and documentable condition of the component at the time of assessment.
  - Incorporate user interviews, work order histories, and other information sources to determine the condition of the component. Include this information in the inspection comment.

Rating	Observation
Green (+)	**Fully Operational** Free of Known or Observable Defects. Keep doing PM required to maintain warranty - no action required
Green	**Fully Operational** Slight Deterioration or Minimal wear. Keep doing PM - no action required
Green (-)	**Fully Operational** Normal wear and/or serviceability defects. Keep doing PM - need to start planning for rehabilitation
Amber (+)	**Reduced Operation** Minor wear and/or serviceability defects. Repairs could be accomplished, and replacement planned within next eight to ten years (Investment of resources could extend life)
Amber	**Reduced Operation** Moderate wear and/or serviceability defects. Repairs could be accomplished, and replacement planned within next six to seven years (Investment of resources could extend life)
Amber (-)	**Reduced Operation** Significant wear and/or serviceability defects. Repairs could be accomplished, and replacement planned within next three to five years (Investment of resources could extend life)
Red (+)	**Loss of Operation** Moderate wear and/or serviceability failure. Repairs could be accomplished, and replacement planned within next two years (Run to failure - further investment unwise)
Red	**Loss of Operation** Significant wear and/or serviceability failure. Repairs could be accomplished, and replacement planned within the next year (Run to failure - further investment unwise)
Red (-)	**Loss of Operation** Complete wear and/or serviceability failure. Replacement needs to be planned immediately

BUILDER Ratings – Age Based

- Age based ratings use BUILDER's built-in degradation curves to calculate the condition index for a component
- Assessor's input the installation year, and the component's condition index is calculated using the percentage of the component's life cycle



Source: D.R. Uzarski, Ph.D., P.E.

Coming to a number - Command Preferences

- Each Command can also set prioritization for what weight to give an assessor's condition rating vs. the component age
- The Condition Rating/Age Split is controlled by the Beta (β) Factor
  - For Army Guard β = 0.5
    - If β = 1, condition rating only matters
    - If β = 0, component age only matters
- Commands can also adjust what components or systems are assessed
  - Army Guard currently inspects 14 systems:
    - A10, A20, B10, B20, B30, C10, C20, C30, D10, D20, D30, D40, D50, E10

Work Items Generation

- Work Items are generated by BUILDER once a component section reaches a set threshold for repair or replacement.
- Each Command sets the trigger levels for repairs.
- Standards for repair can vary between systems, often with the more critical systems having lower trigger levels
- Some systems can be deemed “Run-to-Failure” where no rating can trigger a repair, only excessive age.

Army Standards		Work Triggers		Years
High	Min. CI for Repair	85	Max. RSL for Replacement	2
	Min. CCI for Paint	50	Max RPL for Paint	4

Work Items Generation- What's Missing?

Army Policies (HIGH)		
A10 **	Foundations	Run to Failure
A20 **	Basement Construction	Run to Failure
B10 **	Superstructure	Run to Failure
B20	Exterior Enclosure	MEDIUM
B30	Roofing	HIGH
C10	Interior Construction	MEDIUM
C20	Stairs	MEDIUM
C30	Interior Finishes	LOW
D10	Conveying	MEDIUM
D20	Plumbing	MEDIUM
D30	HVAC	HIGH
D40	Fire Protection	HIGH
D50	Electrical	MEDIUM
E10	Equipment	MEDIUM

** The A10, A20, and B10 systems have been set to **"Run-to-Failure"** as of April 15, 2020, due to these systems' replacement work items not being due until the building's end of life, demolition, or complete modernization.

These Command preferences can affect FCI, since they trigger when work items will appear

Work is triggered when an individual component's rating hits the policy threshold

Calculating BUILDER BCI

$$BUILDER\ BCI = \frac{SCI_1(\$_{s1}) + SCI_2(\$_{s2}) + SCI_3(\$_{s3}) + \cdots SCI_n(\$_{sn})}{\$_{s1} + \$_{s2} + \$_{s3} + \cdots \$_{sn}}$$

The BCI is a condition rating for the overall Building. For each Building, the BCI is computed by taking the average of its Systems' CIs, weighted by replacement cost.

86-100	Fully Operational
70-85	Reduced Operation
0-69	Loss of Operation

Every component and rating collected contributes to a building's BCI Score.

Calculating BUILDER FCI

$$BUILDER\ FCI = 100 \times \left(1 - \frac{2023\ Work\ Item\ Costs}{PRV\ (via\ HQIIS)}\right)$$

FCI only **reflects the most recent year's work items** generated by BUILDER, over the overall building's replacement value.

86-100	**Fully Operational**
70-85	**Reduced Operation**
0-69	**Loss of Operation**

Only sections that generate work items in the next 12 months contribute to a building's FCI Score.

ISR-Q Calculation

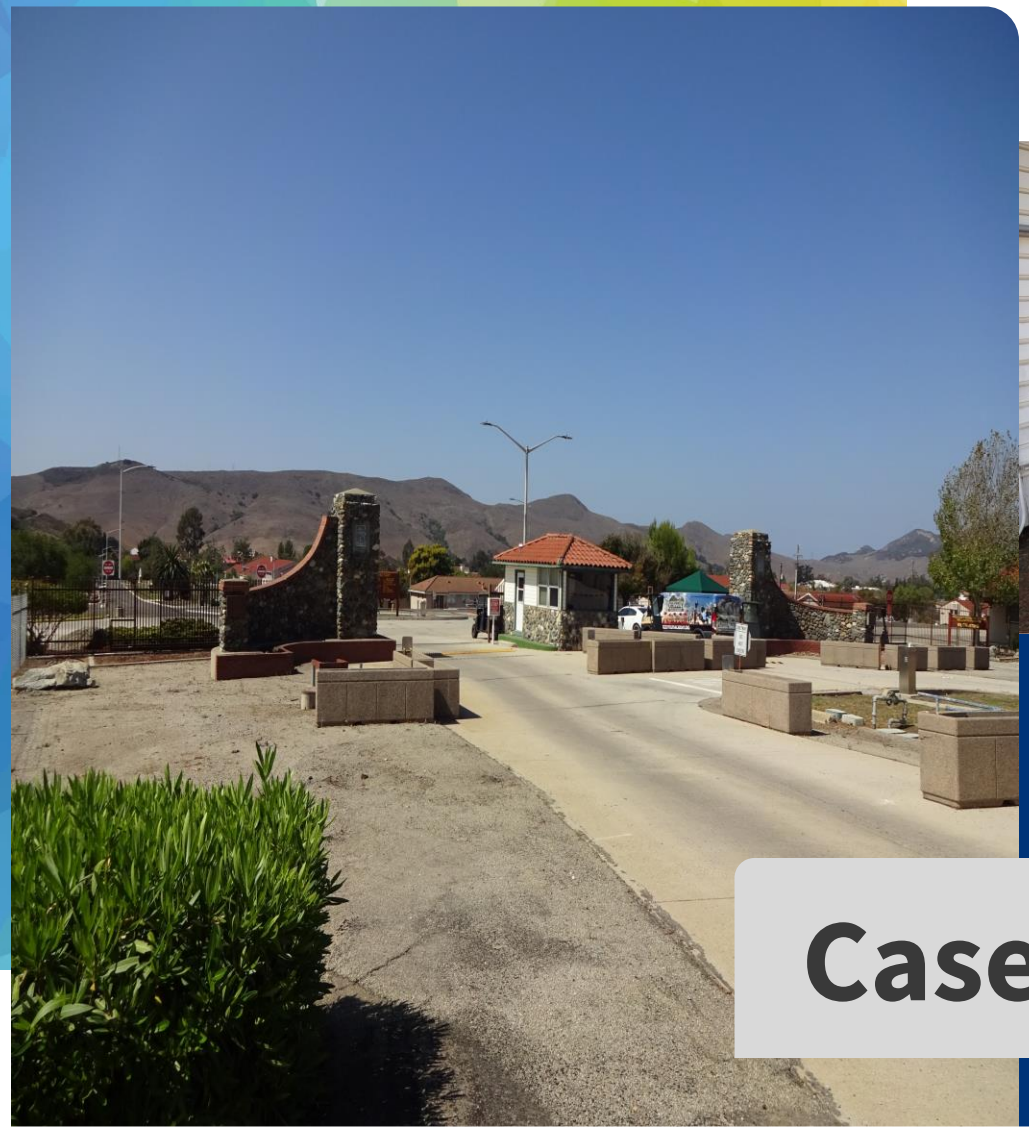
$$Calculated\ Q\ Score = 100 \times \left(1 - \left(\frac{Restoration\ Cost}{Engineered\ Replacement\ Value\ (ERV)}\right)\right)$$

Building type, use, and area cost factors all contribute to the restoration cost of a building.

Q1	90-100	Good Condition
Q2	80-89	Adequate Condition
Q3	60-79	Poor Condition
Q4	0-59	Failing Condition

Very different numbers, but all on the same scale

	ISR-Q	FCI (BUILDER)	BCI
Scale	0-100	0-100	0-100
Variables	Restoration Cost, Engineered Replacement Value	Future Year Work Items, Building PRV	Building Section Scores, Replacement Cost
Colors	Green / Yellow / Red / Black	Green / Yellow / Red	Green / Yellow / Red



TETRA TECH

Section 2

Case Studies

Case Study 1: BLDG 2000 - FMS at Riverside, CA

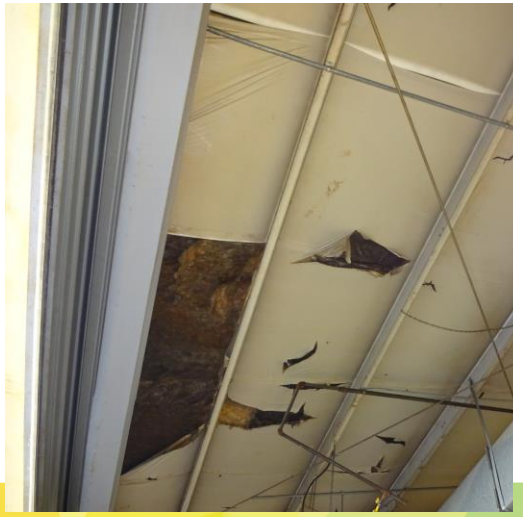
TETRA TECH

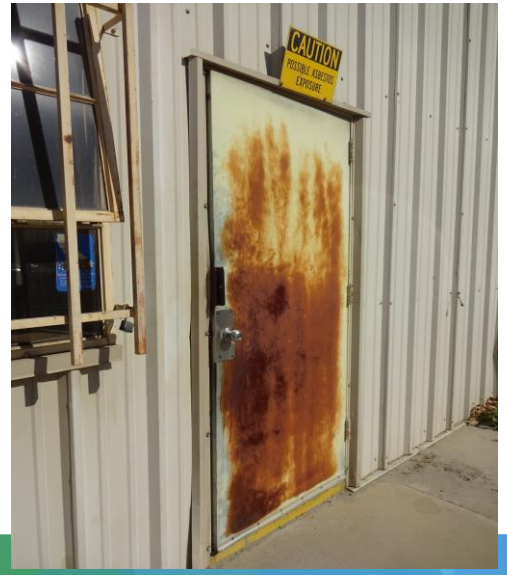
Building Number	2000
Building Name	RIVERSIDE FMS - FMS 4
Location	Riverside, CA
Year Built	1960
Square Footage (SF)	3,825
Building BCI	**74**
Building FCI	**73**

A10	B10	B20	B30	C10	C20	C30	D20	D30	D50	E10
90	89	64	55	79	86	80	67	59	34	80

Case Study 1: BLDG 2000 - FMS at Riverside, CA

- Building had major roof leaks and a compromised exterior enclosure.
- A large, newer awning was added to the building, raising its overall rating.





Case Study 1: BLDG 2000 - FMS at Riverside, CA

- Generated Major Work Items Include (Items that affect FCI):
  - Replacement of electrical grounding system
  - Roof replacement (Main Roof Section has a CI of 33); Building roof rating significantly increased by new large accessory canopy roof.
  - Infrared heater repair
  - Vinyl tile flooring finish repairs

- On-Site Personnel & Assessors Noted:
  - Roof leaks over work areas that needed to be urgently addressed
  - Significant deterioration of finishes
  - Aging mechanical systems needing repairs

The two numbers generally agree. However, the items that are more expensive are in relatively better condition. Weight between cheaper components and more expensive components are not reflecting importance to building integrity.

FCI reflects need for repairs, but because of the smaller percentage of costs, the FCI is not pulled into the "Red" zone.

Case Study 2: BLDG 4113 - Dorm at Camp Roberts, CA

TETRA TECH

Building Number	4113
Building Name	TT ENL BARRACKS/4113
Location	Camp Roberts, CA
Year Built	1941
Square Footage (SF)	4,720
Building BCI	**72**
Building FCI	**96**

A10	B10	B20	B30	C10	C20	C30	D20	D30	D50
84	44	81	82	80	84	77	73	77	65

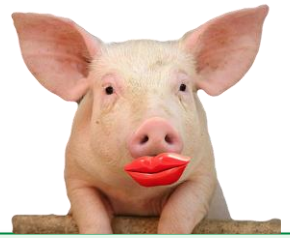
Case Study 2: BLDG 4113 - Dorm at Camp Roberts, CA

TETRA TECH

- Building is an original WWII structure that has recently undergone renovation.
- Buildings were re-wrapped and roofed, but over the original 1941 foundation & structure

Case Study 2: BLDG 4113 - Dorm at Camp Roberts, CA

- Generated Major Work Items Include (Items that affect FCI):
  - Replacement of Branch Wiring
  - Wall Finishes
  - Interior Lighting



- On-Site Personnel & Assessors Noted:
  - Insect damage to framing
  - Pile caps twisted from original configuariton
  - Rot in exposed decking
  - General animal/insect infestation in building

Some major work items show up in the FCI for this building, but the larger structural components are ignored.

BCI reflects the foundation and structural elements that have significant age, despite the new cosmetic improvements.

Case Study 3: BLDG 2404 Battalion HQ at Camp Shelby, MS

TETRA TECH

Building Number	2404
Building Name	Battalion HQ Building
Location	Camp Shelby, MS
Year Built	1964
Square Footage (SF)	2,475
Building BCI	**66**
Building FCI	**94**

A10	B10	B20	B30	C10	C30	D20	D30	D50
66	79	66	68	52	48	64	75	71

Case Study 3: BLDG 2404 Battalion HQ at Camp Shelby, MS

TETRA TECH

- Building is unpainted and unsealed CMU construction with a corner having significant structural cracking
- Aged and damaged interior finishes
- Aged and operationally impaired HVAC equipment

Case Study 3: BLDG 2404 Battalion HQ at Camp Shelby, MS

- Generated Major Work Items Include (Items that affect FCI):
  - Replacement of floor finishes
  - Replacement of exterior doors
  - Wall Repair ($730)
- On-Site Personnel & Assessors Noted:
  - Southwest corner CMU wall has a 12 ft structural crack. Indication of a previous repair attempt.
  - Several areas across ceiling have peeling paint and ceiling is in poor condition
  - Noted deficiencies of HVAC system, as well as general age

FCI does not incorporate major structural issues and poor HVAC performance in the building. It also severely underestimates the cost of repairs.

BCI gives a better indication of complexity of building maintenance issues, as well as a better idea of the magnitude of the "wall repair".

Take Aways

- Each building is underserved by the FCI & BCI metrics in their own way
- BCI is usually lower, and it demonstrates more of what's wrong with each building.
- As infrastructure ages, it is critical to consider what makes buildings function for their intended purpose.

Michelle Mehnert, PE, PMP
michelle.mehnert@tetratech.com
303-249-7495

Colby Hoefar, CFM, LEED AP
colby.hoefar@tetratech.com
719-659-7236

Jacene Phillips, RA
jacene.phillips@tetratech.com
865-964-8405

Contact Us