

DETERMINING A REHABILITATION CONSTRUCTION STANDARD FACTOR
FOR COBRA

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1. Purpose: Determine the cost to rehabilitate existing military construction in the Cost of Base Realignment Actions (COBRA) model. Currently, the algorithm determines the cost for new construction and then multiplies the cost by a factor of 0.75 to arrive at a value for facility rehabilitation (Congress caps a rehabilitation at 75% of military construction (MILCON)). Intuitively this number seems too high and does not accurately reflect the potential savings from rehabilitating buildings. The purpose of this report is to develop a more accurate factor. Based on the information provided below, .47 or 47% is recommended as the new planning factor.

2. References:

- a. Appendix F, Building Systems Work Breakdown Structure (WBS), from TM 5-800-4, Programming Cost Estimates for Military Construction and the
- b. The Army Installation Status Report (FY 2002).

3. Definitions:

- a. Substructure – Includes all work below floor construction (usually slab on grade) and the enclosing horizontal and vertical elements required to form a basement, together with the necessary mass excavation and backfill.
- b. Superstructure – Includes all structural slabs, decks, and supports within the basements and above grade. Structural work includes both horizontal items and vertical structure components. Exterior load bearing walls are not included in the system.
- c. Roofing – Includes all waterproof roof coverings and insulation, together with skylights, hatches, ventilators, and all required trim. In addition to roof coverings, roofing includes all waterproof membrane and traffic toppings over below grade enclosed areas, balconies, etc.
- d. Exterior Closure – Consists of the exterior facing of the facility including all vertical and horizontal exterior closure features excluding the roof.
- e. Interior Closure – Construction inside the exterior wall or exterior skin. It does not include interior structural walls.
- f. Interior Finishes – Finishes applied to interior surfaces, including the interior skin of exterior walls.
- g. Specialties – Specialty items permanently fixed in place.
- h. Plumbing – Includes all water supply and waste items within the building.

- i. Heating, Ventilating, and Air Conditioning (HVAC) – Includes all equipment, distribution systems, controls, and energy supply systems required by HVAC systems.
- j. Special Mechanical – Includes standard fire protection and suppression systems.
- k. Electrical – Includes electric power and lighting.
- l. Special Electrical – Includes provisions for communications, security, and alarm systems.
- m. Equipment – Fixed and moveable equipment.
- n. Conveying Systems - Includes elevators, escalators, pneumatic tube systems, conveyors, chutes, and others.
- o. Amber Building – Army term for a building that will impair mission performance.
- p. Red Building – Army term for a building that will significantly impair mission performance.

4. Assumptions:

- a. Since the analysis uses data from the Army, I assume that installations in the other Services have buildings with similar Building System Work Breakdown Structure (COBRA is a joint analysis tool).
- b. I also assumed that the overall status of the other Services is similar to the overall status of all buildings in the Army.
- c. A building in a “red” condition only has an adequate substructure, superstructure, and exterior closure. All other parts of the structure need to be replaced.
- d. An “amber” condition has the same adequate systems as a “red” building, but it also has adequate roofing, plumbing, HVAC, and electrical.

5. Background:

- a. The Building Work Breakdown Structure (WBS) divides a building into 14 different “systems”. Each type of building has a different set of ratios of WBS system costs to facility costs. For example, the substructure of an administrative building has a ratio of 11.00, which means the substructure is 11% of the building’s total cost. The WBS in TM 5-800-4 contains 32 different building types. Thirteen of the 32 facility types matched the list of facilities that are included in the COBRA model. The list of COBRA facility types is found in Appendix 1. These 13 facility types make up 23.79% of the total DoD PRV. There are 398 other facility types that make up the other 76.21 % of PRV, so the

13 facility types chosen for analysis make up a large part of the total. The only facility not included in the WBS that has a significant PRV percentage is family housing with a PRV percentage of 7.41%.

b. The rehabilitation factor was determined using a two-step process. First, a factor to rehabilitate a “red” building for each facility type was calculated. Red buildings were assumed to have an adequate substructure, superstructure, and exterior closure. The cost factor was derived by adding the 11 system ratios together produced a percentage of facility cost required for repairing or replacing the remaining systems. A copy of the spreadsheet used to calculate the factors can be found in Appendix 1. The red factors are listed in Table 1.

Facility Type	Red Factor (%)
Administration Facility	59.28
Applied Instruction Building	67.87
Enlisted Barracks	72.10
Brigade Headquarters	59.24
Battalion Headquarters	59.08
General Instruction Building	63.65
General Purpose Warehouse	54.82
Physical Fitness Center	60.22
Aircraft Maintenance Hanger	60.80
Dining Facility	80.01
Health Clinic	87.28
Reserve Center	65.86
GS Vehicle Maintenance Shop	47.35

Table 1

Second, a similar method was used to find a factor for amber buildings. In addition to the adequate systems in a red building, an amber building also has adequate roofing, plumbing, HVAC, and electrical systems. The amber cost factor was derived by adding the remaining seven system ratios to produce a percentage of facility cost required to repair or replace the remaining systems derived the amber cost factor. The amber factors can be found in Table 2.

Facility Type	Amber Factor (%)
Administration Facility	28.80
Applied Instruction Building	27.08
Enlisted Barracks	39.30
Brigade Headquarters	26.19
Battalion Headquarters	24.07
General Instruction Building	29.48
General Purpose Warehouse	13.12
Physical Fitness Center	29.90
Aircraft Maintenance Hanger	27.93
Dining Facility	16.73
Health Clinic	12.41
Reserve Center	32.79
GS Vehicle Maintenance Shop	18.47

Table 2.

- c. Because the COBRA model uses one factor to determine the costs to rehabilitate a building, we needed to reduce 26 different values down to 1. Calculating an overall red factor and amber factor for all buildings/facilities did this. Appendix 1 has the percent DoD PRV for all of the facilities included in the COBRA model. The total percent DoD PRV of the 13 building chosen for analysis was 23.79. To determine the red factor, a weighted average red factor was calculated by summing the products of the individual building red factors and the individual building percent DoD PRV, then dividing that sum by 23.79. The same method was used to find the amber factor. The red factor is 64.31 while the amber factor is 29.46 (see Appendix1, weighted average).
- d. The second step was to determine a single factor for rehab construction. COBRA does not delineate between red and amber buildings. The Army's Installation Status Report (ISR) was used to determine the weighted averages for the total square footage of Army Facilities that are considered red and amber (see Appendix 2). All of the possible square footage of red classified buildings was summed and divided by the total square footage of buildings in the Army. The same method was used to find the percentage of amber buildings. Twenty-four percent of the Army's square footage is red and 43% is amber. The remaining facilities are green and do not require rehab.
- e. There are several concerns with using ISR data. First, the data is from fiscal year 2002, so may not include facilities upgrades over the past two years. Second, the ISR includes only buildings reported in units of square feet. Barracks and family housing are reported using different units. To account for these facilities a one to one ratio was used. This should produce a higher standard factor and simplify the calculation. The final factor is the average of the two factors. This gives a value of .46885, or 0.47.
6. Recommendation: Recommend that the JPAT change the rehab standard factor from 0.75 to 0.47. The 0.75 value was based on a statutory requirement with no structural analysis behind it. The 0.75 value is too conservative. If we use it, then the COBRA model could lose the potential savings involved in rehabbing buildings. The 0.47 value was determined using the most up to date technical manual published by the Army Corps of Engineers. The ISR data shows that using a one to one ratio is a conservative estimate. Finally, the 0.47 value is close to the 0.4 value recommended by the contractor R&K that resulted from their analysis.

Appendix 1:

Building Systems Work Breakdown Structure

WBS Description	ADMIN	AIB	BARRCK	BRDGHQ	BTTNHQ	CLSRM	GPWH	GYM	HANGR	KIT/DN	MEDCL	RESREV	SHOPGS	
FAC	6100	1712	7210	6102	6101	1711	4411	7421	2111	7220	5500	1714	2141	
% DoD PRV	4.9	0.99	6.26	0.76	1.41	0.97	0.88	0.68	2.21	0.89	0.46	1.94	1.44	23.79
Cat. Code	61050	17130	722111	61011	61012	17120	44110	740034	21110	72210	55030	17140	21420	
1 Substructure	11.00	6.73	4.5	7.13	6.69	7.89	9.5	5.22	7.2	11.06	4.59	10.39	13.46	
2 Superstructure	17.94	12.1	12.7	14.37	10.7	12.91	19.22	13.36	16.16	3.34	3.17	9.85	28.74	
3 Roofing	4.06	5.23	2.3	3.2	2.83	5.56	12.1	5.49	13.88	3.63	2.28	10.19	5.75	
4 Exterior closure	11.78	13.3	10.7	19.26	22.2	15.55	16.46	21.2	15.84	5.59	4.96	13.9	14.39	
5 Interior construction	13.10	11.18	18.1	7.36	17.35	12.94	6.05	2.28	12.06	2.29	3.61	19.02	5.6	
6 Interior finishes	9.73	10.73	18.6	10.83	5.87	8.98	1.82	12.9	7.86	12.84	3.57	11.32	2.13	
7 Specialties	0.89	0.38	0	1.03	2.39	4.06	1.81	3.9	1.44	0.61	1.13	1.14	3.31	
8 Plumbing	3.10	3.3	17.3	5.41	3.31	3.43	1.52	3.57	3.64	22.15	5.59	10.98	3.22	
9 HVAC	13.86	8.28	5.2	17.71	17.62	15.45	16	11.42	6.59	21.12	4.7	1.76	7.89	
10 Special mechanical	0.00	1.5	2.1	0	1.85	1.57	2.33	0	2.5	0	0	0	2.12	
11 Electrical	9.46	23.98	8	6.73	8.46	9.73	12.08	9.84	8.76	16.38	62.3	10.14	9.25	
12 Special electrical	3.48	3.29	0.5	6.97	0.67	1.93	1.11	0.93	2.32	0.99	2.4	1.31	1.02	
13 Equipment	1.60	0	0	0	0	0	0	9.89	1.75	0	1.7	0	3.12	
14 Conveying system	0.00	0	0	0	0	0	0	0	0	0	0	0	0	
	100	100	100	100	99.94	100	100	100	100	100	100	100	100	
RED	59.28	67.87	72.10	59.24	60.41	63.65	54.82	60.22	60.80	80.01	87.28	65.86	43.41	
AMBER	28.80	27.08	39.30	26.19	28.19	29.48	13.12	29.90	27.93	16.73	12.41	32.79	17.30	
	290.47	67.1913	451.346	45.0224	85.1781	61.741	48.24	40.95	134.368	71.209	40.149	127.7684	62.5104	
	141.12	26.8092	246.018	19.9044	39.7479	28.596	11.55	20.332	61.7253	14.89	5.7086	63.6126	24.912	

Weighted Average

64.15

29.63

46.89

Appendix 2- ISR Extract

FCG_Desc	FCG	Measure	Total_Assets	Red_Assets	Pct_Red	Amber_Assets	Pct_Amber
Information Sys Fac	F13115	Square Feet	5788569.84	1044584	18	2870951.54	50
Air Nav Aids Buildings	F13300	Square Feet	228784	42775	19	94807	41
Airfield Opns Buildings	F14110	Square Feet	631044	80408	13	284679	45
Aviation Unit Opns Bldgs	F14112	Square Feet	544180	150825	28	274207	50
CIDC Facilities	F14114	Square Feet	540312	120628	22	230862	43
Training Aids Spt Cntr	F14129	Square Feet	1367829	268802	20	735287	54
Storage Spt Facilities	F14133	Square Feet	4357338.02	494950.02	11	1950664	45
EOC / SCIF Facilities	F14161	Square Feet	1201805.54	159096	13	566641.54	47
Production Plt Spt Facs	F14169	Square Feet	22912	1890	8	843	4
Brigade HQ Bldgs	F14182	Square Feet	3294656.5	468890	14	1760674.5	53
Battalion HQ Buildings	F14183	Square Feet	7434357.3	1657938.3	22	3561500	48
Company HQ Buildings	F14185	Square Feet	19421984.08	4002069.5	21	9897604.58	51
Ship Opns Bldgs	F14310	Square Feet	199569.69	24105.38	12	65753	33
Band Training Facilities	F17115	Square Feet	491765	187789	38	244255	50
Organizational Classroom	F17119	Square Feet	2826122	466467	17	1263331	45
Gen Instruct Buildings	F17120	Square Feet	13779138.66	2878402	21	6149747.66	45
Indoor Firing Ranges	F17121	Square Feet	508839	283805	56	89239	18
Physical Educ Trng Bldgs	F17125	Square Feet	583222	514234	88	11888	2
Compact Item Rpr Instruct	F17131	Square Feet	770560	12419	2	487070	63
Gen Item Repair Instruction	F17132	Square Feet	777994	214645	28	418862	54
Vehicle Maint Instruction	F17133	Square Feet	1904861	384884	20	770474	40
Aircraft Maint Instruction	F17134	Square Feet	874910	6762	1	818282	94
Lab Instruction	F17135	Square Feet	388990	226680	58	124348	32
Automation-Aided Instruct	F17136	Square Feet	1185736	218170	18	593673	50
Material Handling Instruct	F17137	Square Feet	62719	0	0	53945	86
Limited Use Instruction	F17138	Square Feet	2058339	582030	28	694998	34
USAR Center	F17140	Square Feet	22342328.02	5335724.34	24	11736304.15	53
Training Centers - NG/AR	F17142	Square Feet	1791363	222997	12	793849	44
Training Centers - ARNG	F17180	Square Feet	60436931.88	29015541.02	48	23227670.9	38
Simulator Facilities	F17200	Square Feet	3323421.9	377916	11	1552652	47
Aircraft Maint Facilities	F21110	Square Feet	14616429.39	4598087.96	31	6481369.21	44
Guided Missile Maint Bldg	F21210	Square Feet	636139	39029	6	95174	15
Ship Maint Facilities	F21310	Square Feet	170392	23483	14	63709	37
National Guard Maint Fac	F21407	Square Feet	7182865.84	2561208.94	36	2697493	38
Army Reserve Maint Fac	F21409	Square Feet	5388008.29	1713574.2	32	2288067.09	42
Vehicle Maint Shops	F21410	Square Feet	20745647.57	5869218.76	28	9919243.81	48
Depot Maint / Reblid Shops	F21440	Square Feet	4002726.5	337940.5	8	1327510	33
Depot Wpns Maint Shops	F21500	Square Feet	424667	8936	2	196575	46
Depot Ammo Maint Fac	F21600	Square Feet	1120754	223434	20	510329	46
Ammunition Repair/Inst	F21670	Square Feet	21871	17071	78	0	0
Depot Comm - Elect Shops	F21700	Square Feet	2771633	112101	4	1166517	42
DOL/Proc Item & Equip Maint	F21800	Square Feet	1465784	351525	24	417484	28
Vehicle Main DOL/ DEH/DPW	F21885	Square Feet	10495513.88	2285203.88	22	4220976	40
Install Maint/Repair Facs	F21900	Square Feet	5384130.77	865636	16	2948921.77	55
Aircraft Prod Facilities	F22100	Square Feet	1626	1626	100	0	0
Guided Missile Prod Fac	F22200	Square Feet	137495	6439	5	76367	56
Tank / Automotive Prod Fac	F22400	Square Feet	189199	95940	51	10048	5
Wpns Prod Facilities	F22500	Square Feet	2951641	356660	12	2491251	84
Ammunition Prod Fac	F22600	Square Feet	2259408	681501	30	422898	19
Misc Prod Facilities	F22800	Square Feet	92254	7255	8	74469	81
Install Support Prod Bldg	F22960	Square Feet	3786	3281	87	0	0
RDT&E Laboratories	F31000	Square Feet	3712376.23	953279.23	26	1030049	28
Aircraft RDT&E Facilities	F31100	Square Feet	432858	34483	8	380403	88
Missile / Space RDT&E Fac	F31200	Square Feet	1671905	414681	25	840673	50
Tank / Automotive RDT&E Fac	F31400	Square Feet	714854	60234	8	403235	56