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Title: Los Alamos Recapitalization Project Prioritization— Summary Using Generic Project Names

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Los Alamos Recapitalization Project Prioritization—
Summary Using Generic Project Names

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Summary
The purpose of this document is to provide a standard method of prioritizing proposals for NNSA's NA-50 Office of Safety, Infrastructure, and Operations recapitalization projects under the auspices of the Los Alamos Weapons Infrastructure Program Office (WI-PO). The framework described here has the goal of providing a consistent method by which all proposals are ranked from a pre-determined set of criteria.[1] The results of this study are not expected to be definitive but rather provide input for management decisions. The top-ranked projects can be pursued further to become the focus for an appropriate fiscal year NA-50 funding cycle.

A recapitalization team of subject matter experts (SMEs) and managers used multi-attribute decision analysis to determine the top priority NA-50 projects for FY2022. Ratings of seven criteria against twelve projects were combined with four weighting perspectives to provide the final results.

Methodology
The methodology used is multi-attribute decision analysis, applied via a commercial software package called Criterium Decision Plus[2] to build an analytical hierarchy process (AHP) model and calculate the results. During the first step of the process, "Brainstorming," the goal of the model (*Select Recapitalization Project*) is defined and possible evaluation criteria are considered. In building the model there are four key rules that need to be followed when selecting criteria to score projects. First, all criteria must remain independent from each other to avoid double counting. Second, the model should only include the absolutely essential criteria, i.e., having fewer criteria is better. Third, each criterion needs to be well defined and easy to understand. Fourth, each criterion needs to be capable of being scored fairly. All four rules must be strictly applied and evaluated using subject matter experts (SMEs). Once all criteria have been deemed relevant and the hierarchy is built, the scoring process may begin, i.e., "Rate the Hierarchy." All projects receive scores or ratings based on available supporting documentation and information provided by appropriate SMEs.

The hierarchy of criteria is shown in Figure 1. The goal of selecting a recapitalization project is seen on the left, and to the right are the four top criteria: Programmatic Capability Gaps, Infrastructure Gaps, Economics, and Environmental Sustainability. These aid in attaining the goal of selecting a project proposal. Further to the right, two top criteria are divided into sub-criteria to account for additional data fidelity.

The next step in the decision analysis process is to rate the hierarchy; in this case, twelve alternative NA-50 projects are scored against each criterion. A seven-component score ranging from *Finest* to

[1] Full paper: Booth, Steven R.; Kniss, Paul Ryan, "Los Alamos Recapitalization Project Prioritization—Decision Analysis Model and Results," Official Use Only, LA-CP-20-20043, January 2020.
[2] Infoharvest, Inc., Seattle, WA, www.infoharvest.com.

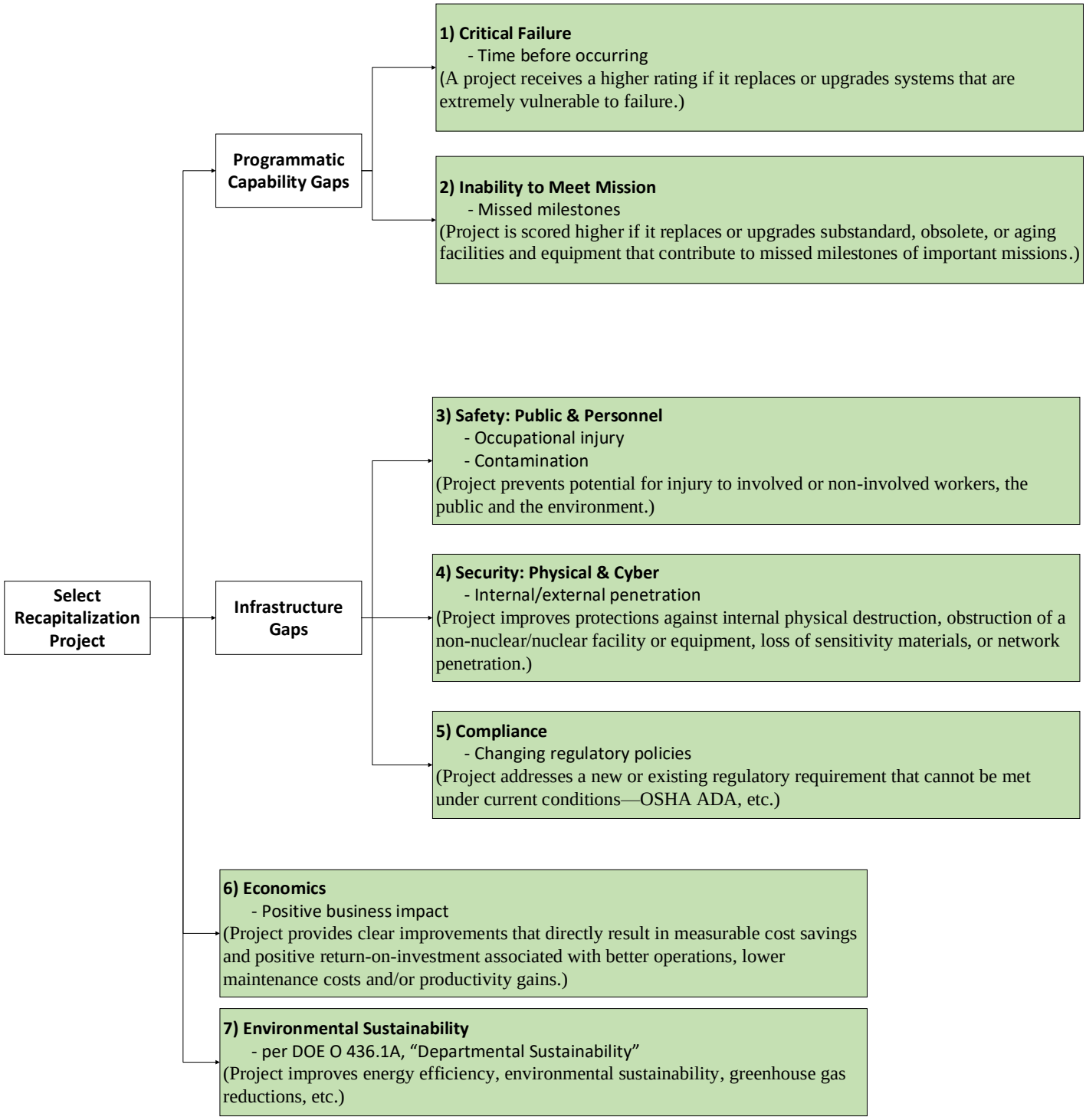

Figure 1: The hierarchy of the decision analysis model shows seven criteria (in green) that are used in evaluating NA-50 projects.

Unsatisfactory is given for each alternative against each criterion: *Finest* (100 points), *Excellent* (83.3 points), *Above Average* (66.7 points), *Average* (50 points), *Below Average* (33.3 points), *Poor* (16.7 points), and *Unsatisfactory* (0 points). The scores for the model are listed in Table 1. The recapitalization team's goal was to be realistic and consistent when applying scoring values.

TABLE 1
Criterion Scores for NA-50 Recapitalization Projects, Generic Names

Criterion	*Project 1*	*Project 2*	*Project 3*	*Project 4*	*Project 5*	*Project 6*	*Project 7*	*Project 8*	*Project 9*	*Project 10*	*Project 11*	*Project 12*
Critical Failure	7	7	7	7	6	1	4	4	6	6	4	7
Inability to Meet Mission	7	6	6	6	7	1	6	1	5	6	7	7
Safety	7	7	7	4	5	3	5	5	5	6	6	6
Security	1	1	1	1	4	1	5	1	3	5	6	1
Compliance	7	7	7	5	6	7	5	7	3	2	3	1
Economics	7	6	6	4	6	1	6	1	4	5	7	7
Environmental Sustainability	4	3	3	6	4	1	5	1	4	7	7	6

Legend
7 Finest
6 Excellent
5 Above Avg.
4 Avg.
3 Below Avg.
2 Poor
1 Unsatis.

The basic algorithm is to multiply how each alternative scores against each criterion by the relative importance of that criterion (i.e., its weight). Those products are then summed over all the criteria to provide a total decision score, thus serving as a measure of how well each alternative fits the decision model.

Decision analysis uses a weighting scale for the criteria that is applied to capture their relative importance. A five-component user scale that ranges from *Critical* (100 points) to *Trivial* (0 points) is assigned to each weight. Each criterion score provided by project evaluation team is multiplied by its relative weight to calculate a rank. This process continues for all the criteria, and the results are summed to produce a final score. In the Equal-Weights default for the FY22 NA-50 project prioritization effort the sub-criteria weights are shown in Table 2. Two top criteria have sub-criteria that divide the weights evenly into two (Programmatic Capability) or three (Infrastructure) parts.

TABLE 2
Weights of Criteria for Several Perspectives

	Weighting Scheme			
Criterion	**Equal**	**Weapons Program**	**NA-50 {1}**	**Weapons Infrastructure**
Programmatic Capability Gaps				
1) Critical Failure	0.188	0.333	0.175	0.25
2) Inability to Meet Mission	0.188	0.333	0.175	0.25
Infrastructure Gaps				
3) Safety: Public and Personnel	0.125	0.111	0.117	0.24
4) Security: Physical and Cyber	0.125	0.111	0.117	0
5) Compliance	0.125	0.111	0.117	0.093
6) Economics	*0.125*	*0*	*0.20*	*0.113*
7) Environmental Sustainability	*0.125*	*0*	*0.10*	*0.053*
Total	**1.00**	**1.00**	**1.00**	**1.00**

{1} Adapted from Office of Safety, Infrastructure, and Operations, "Program Management Plan," September 2019, Figure 11, p. 25.

Three additional weighting schemes are used to generate a sensitivity analysis for the model. These weighting options are loosely designed to reflect hypothetical perspectives of a Weapons Director, an NA-50 Director, and a Los Alamos Weapons Infrastructure Director. The weights are not meant to be precise, but rather are a means to exercise the model to see if the results are robust and repeatable across different perspectives.

Hypothetical Weapons Director concerns primarily fall into the mission capabilities gaps where each sub-criterion receives one-third of total weight; the infrastructure gaps sub-criteria receive eleven percent each. NA-50 Director priorities based on the NA-50 Program Management Plan (PMP) of September 2019 have less emphasis on programmatic gaps and more on economics and environmental sustainability.

The final weighting scheme more precisely targets criteria that are relevant to WI-PO by assigning an individual weight to each of the seven criteria. This results in the majority of emphasis being applied to Critical Failure, Inability to Meet Mission, and Safety; the three criteria combine for about three-quarters of the total weight. The remaining criteria receive much lower emphasis relative to the other perspectives.

Results

The results of the analysis are shown in Table 3 for the twelve FY22 NA-50 projects. Some alternatives have scores that are essentially the same. For example, under Weapons Program weighting three projects rank within 0.001 of each other: Project 11 (0.102), Project 1 (0.101), and Project 10 (0.100). Although these are ranked #2, #3, and #4 in Table 3, the reader is cautioned not to consider those ranks as definitive.

The reader should note the large difference in the ranking order under the Weapon Infrastructure perspective compared to the other three weighting schemes. Equal, Weapons Program, and NA-50 weighting structures provide fairly stable results, where the top five projects are somewhat consistent. However, the Weapon Infrastructure perspective represents quite different priorities compared to the other three. Appropriate consideration should be used in the evaluation and comparison of this weighting option to others. The cumulative calculations for the model under the Weapons Infrastructure weights is shown in Figure 2.

TABLE 3
Project Ranks under Several Weighting Perspectives

	Weighting Scheme			
Recapitalization Project	Equal	Weapons Program	NA-50	Weapons Infrastructure
Project 11	#1	#2	#1	#6
Project 10	#2	#4	#3	#7
Project 5	#3	#1	#2	#5
Project 7	#4	#7	#4	#9
Project 1	#5	#3	#5	#1
Project 2	#6 (tie)	#5 (tie)	#6 (tie)	#2 (tie)
Project 3	#6 (tie)	#5 (tie)	#6 (tie)	#2 (tie)
Project 12	#8	#8	#8	#4
Project 4	#9	#9	#9	#8
Project 9	#10	#10	#10	#10
Project 8	#11	#11	#11	#11
Project 6	#12	#12	#12	#12

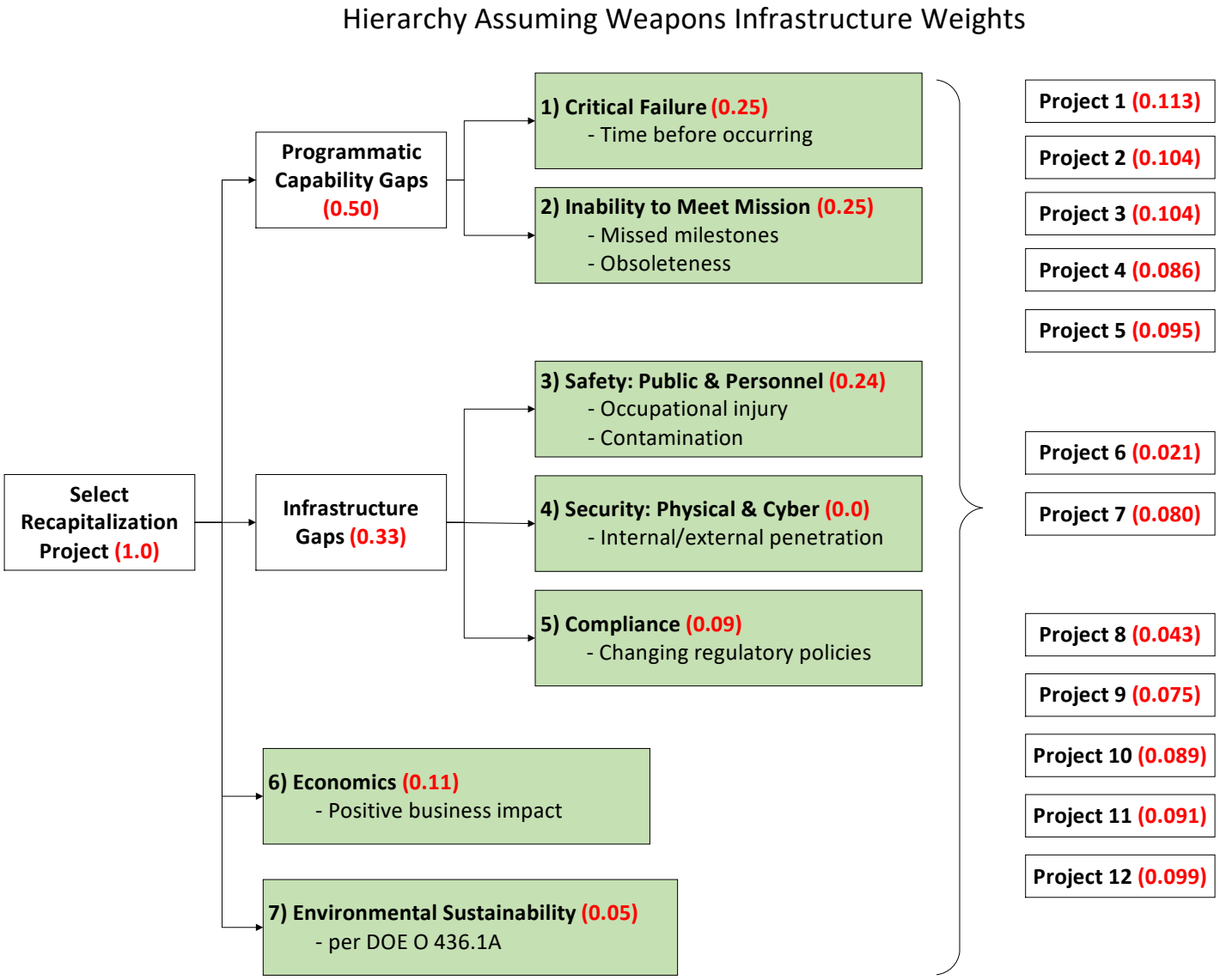

Figure 2: Cumulative decision analysis scores under the Weapons Infrastructure weighting scheme.