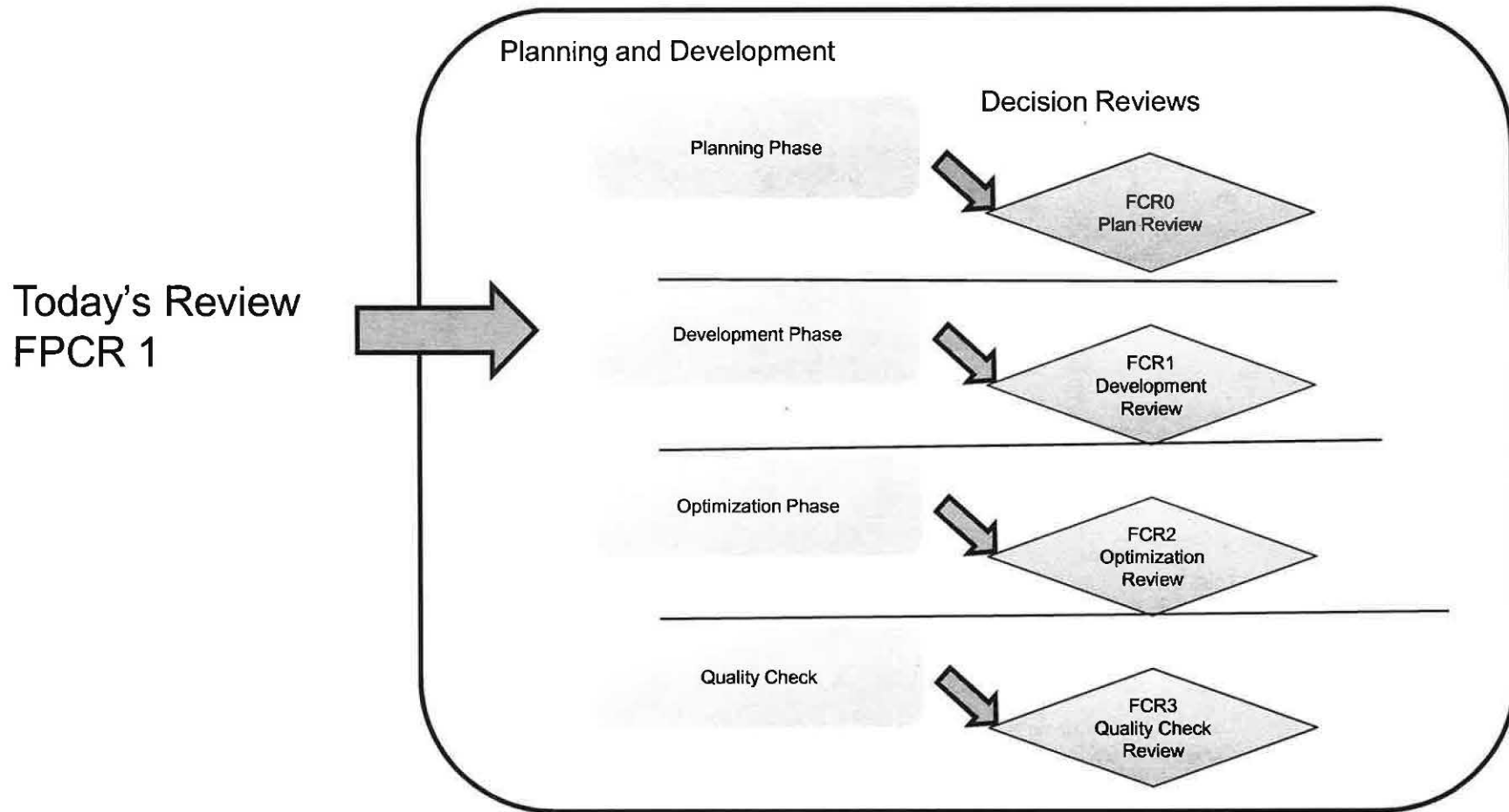
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Field Process Change Review 1 Development Review MESSENGER CABLE

FPCR PROCESS OVERVIEW



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Purpose

Define the Purpose of this review.

- Review the results of the development efforts and obtain approval for the initial deployment at the NCPV 2 Project (Beta installation). Engage CAB for engineering support to address permitting issues per their offer.

What is being recommended?

- Remove DC feeders from cable tray and install in trench.
- Replace the cable tray with a messenger cable to support string wiring.
- Compare costs to alternate steel cable tray proposal.

What is recommendation based on?

- Recommendation is predicated upon the success of the Slalom initiative and the savings in material cost resulting from the deletion of the cable tray.

What is needed from the stakeholders in this review?

- Approval to take actions to support this recommendation

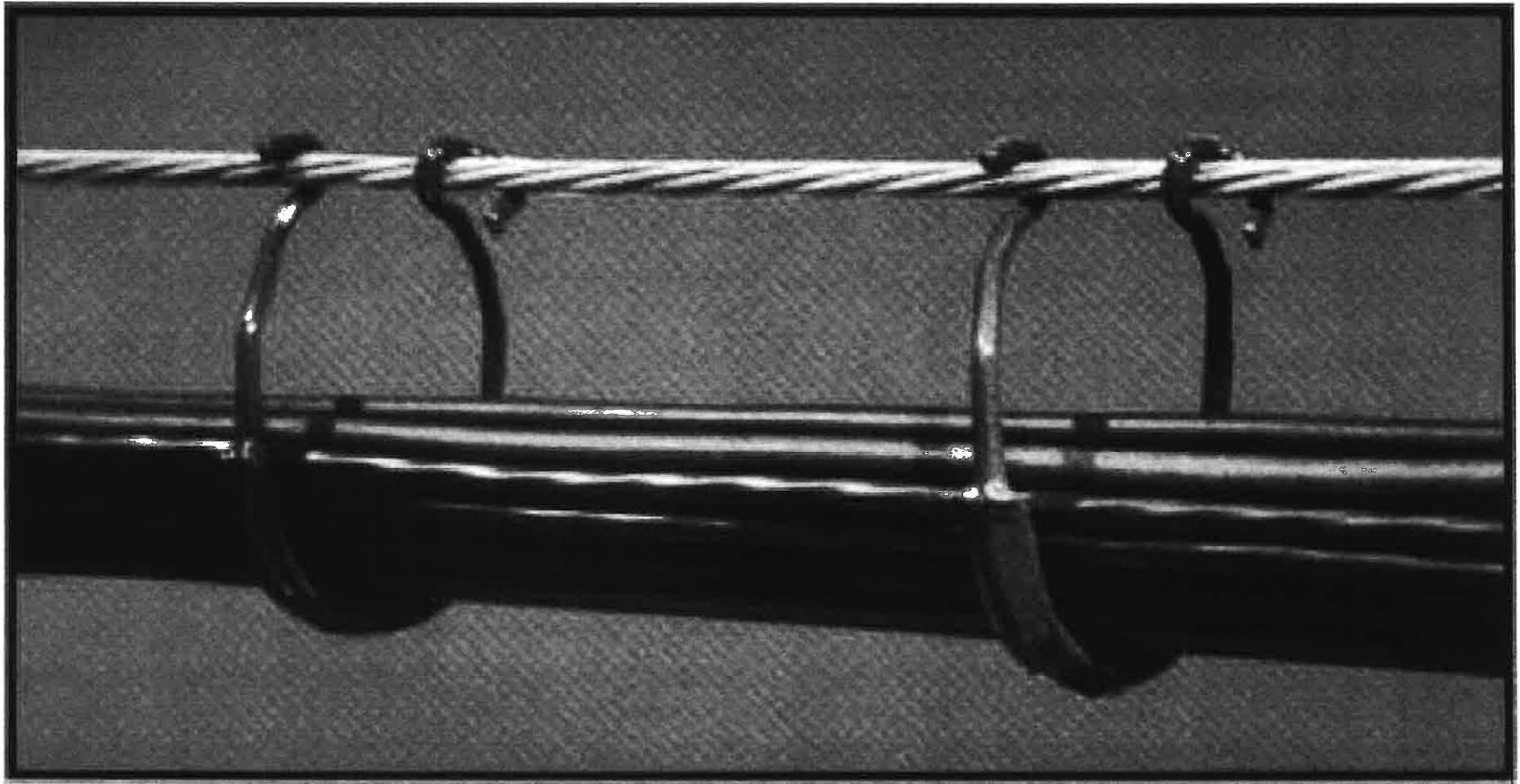
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3

Messenger Cable



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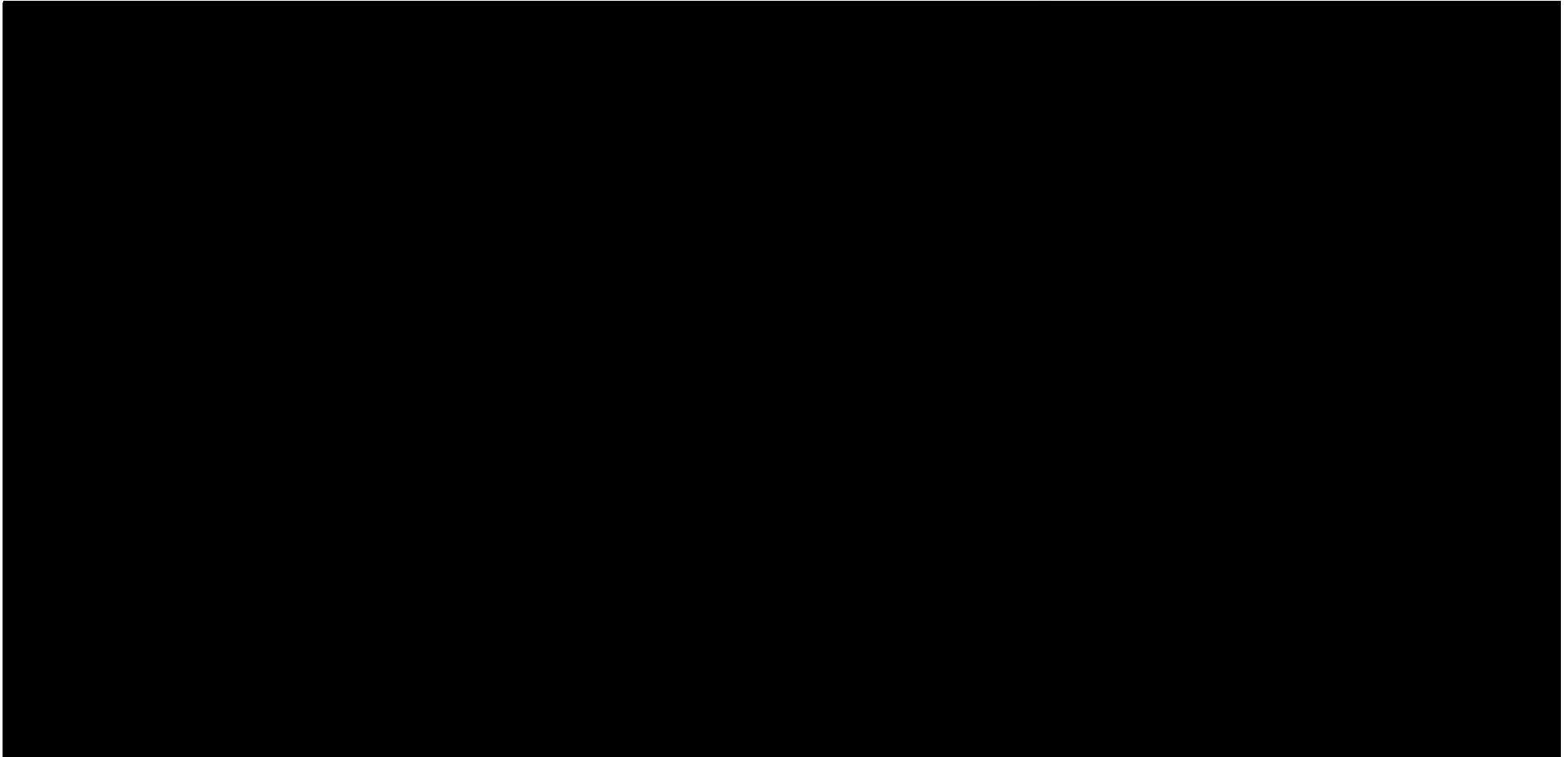
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Field Process Change Details



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FPCR-1 Disposition

MESSENGER CABLE

FPCR-1 Outcome:

Approvers	Approved (Signature & Date)	NOT Approved (Signature & Date)
[REDACTED]		
[REDACTED]		
[REDACTED]		
[REDACTED]		
[REDACTED]		
[REDACTED]		
[REDACTED]		
[REDACTED]		

Functional Representatives
[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]

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Change Executive Summary

- Replace cable tray with messenger cable to support string wiring
- Reason for Change:
 - Cost reduction due to reduced material costs, shipping and installation labor
- Cost Impact
 - [REDACTED]
- Impact:

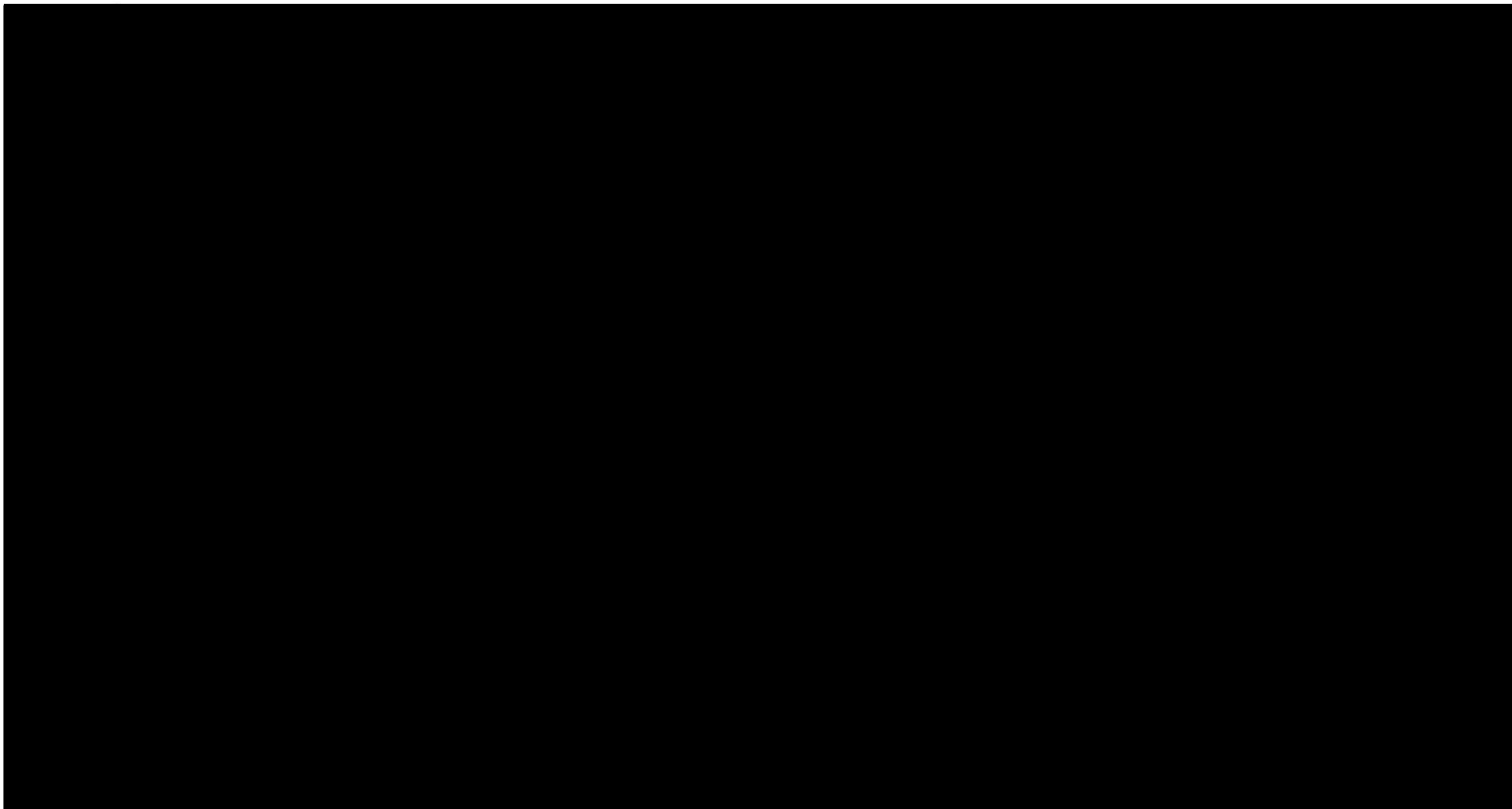
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[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]

[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]

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Change Summary



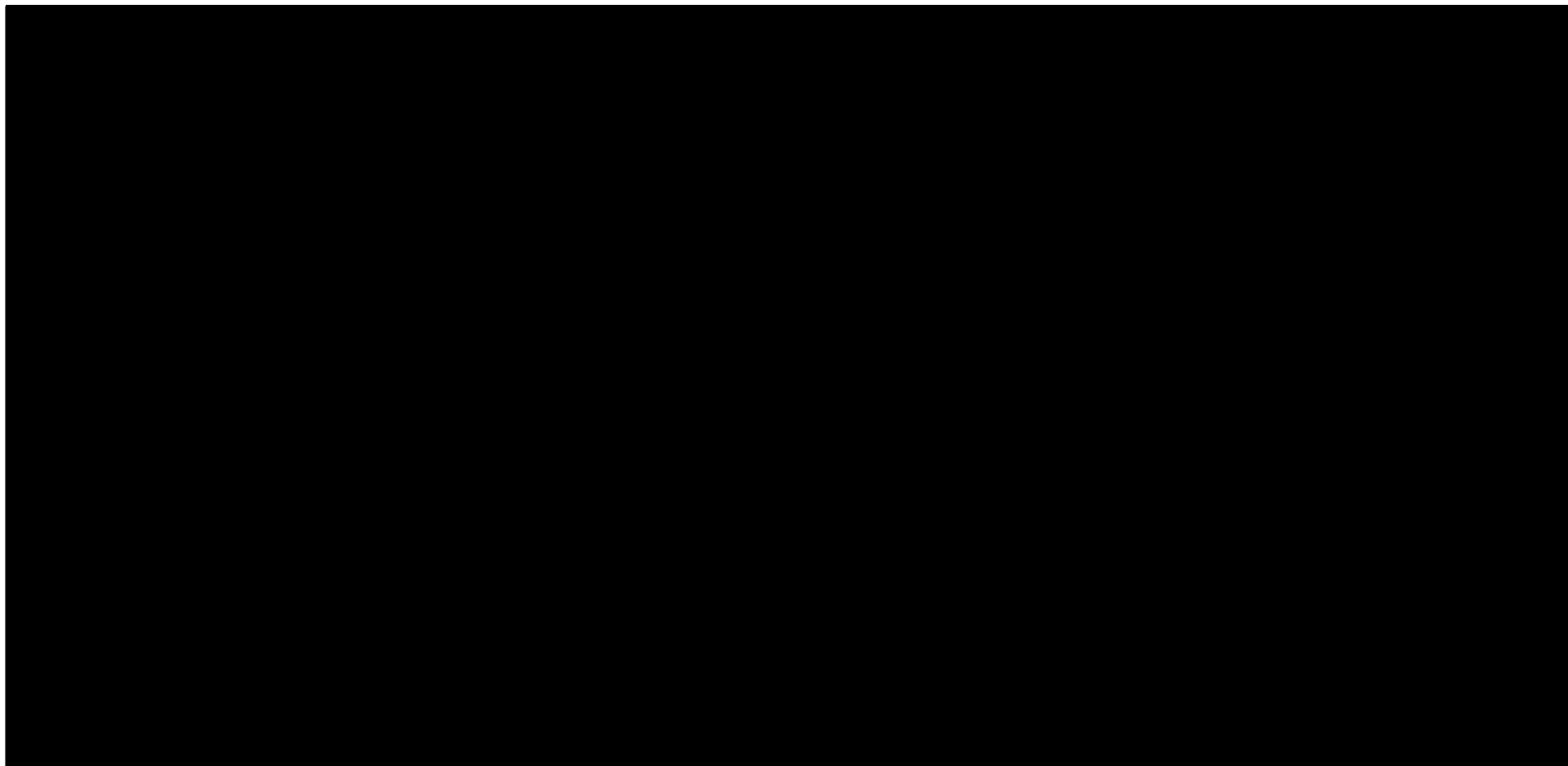
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Bracket

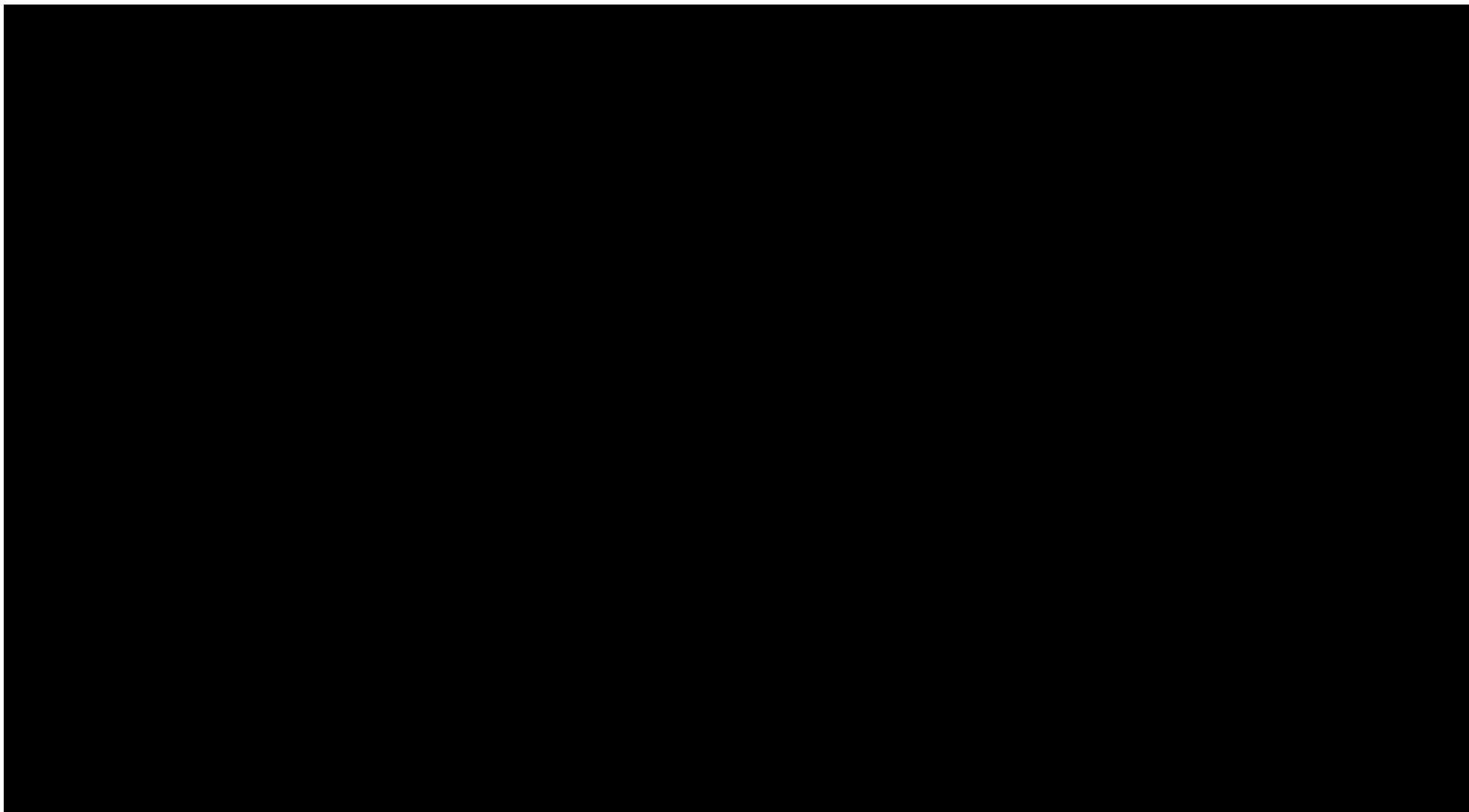


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Transition Hose

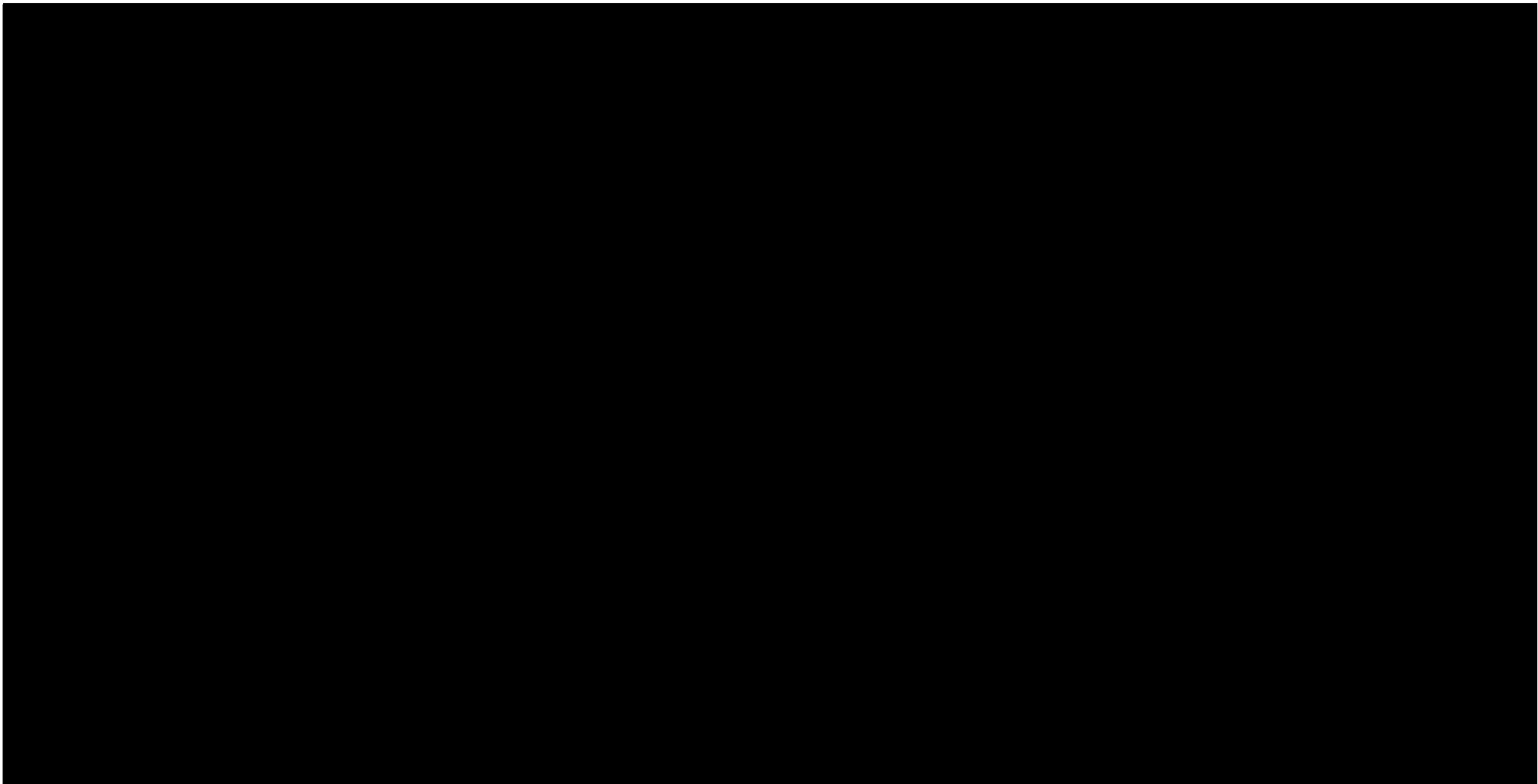


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Elevation

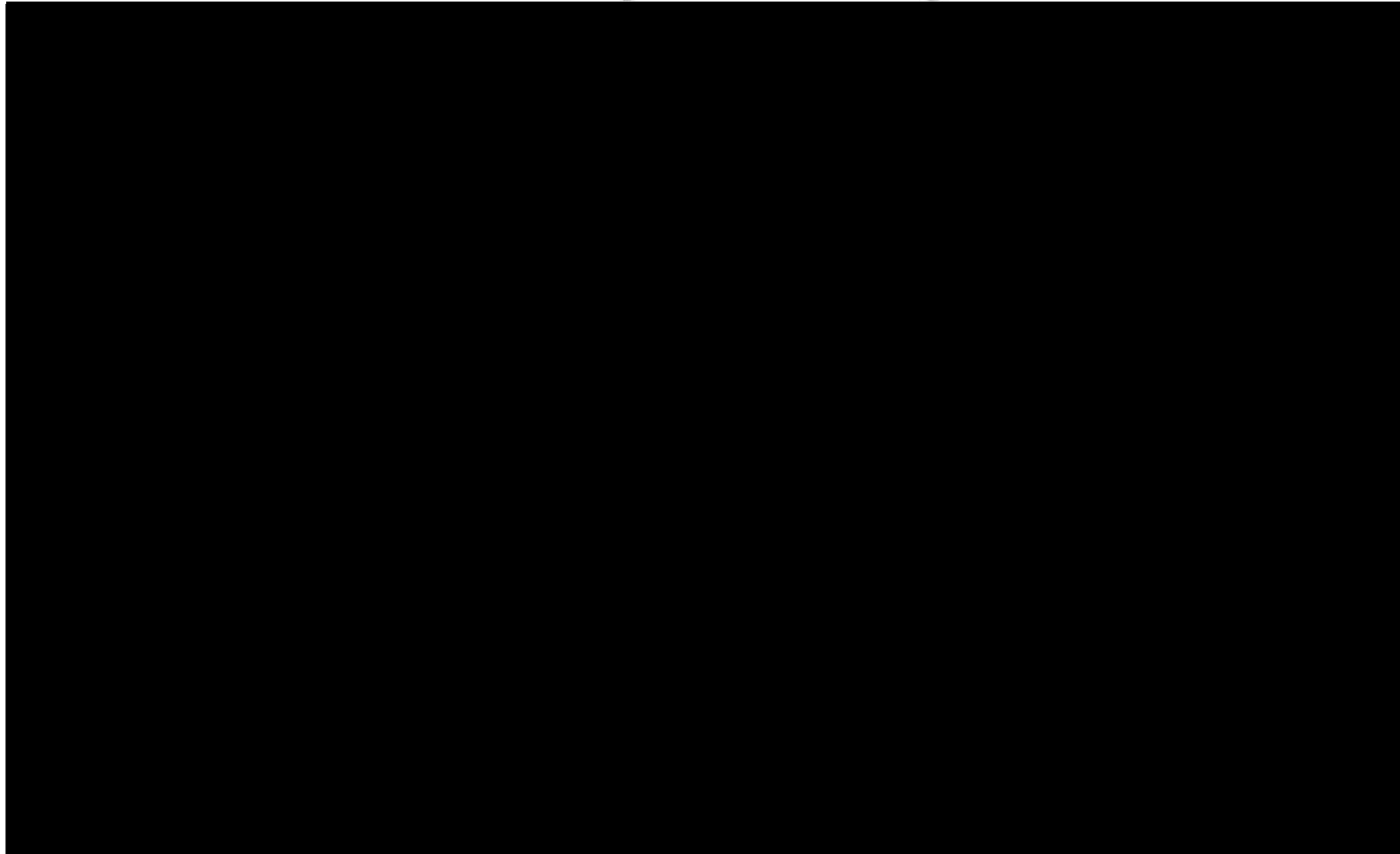


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NCPV2 Beta Test Proposed budget



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NCPV2 Beta Test Plan

Step	Item Description	Resolution
1	•Receive approval for Beta test	
2	•Decide on location of beta installation	•NCPV2, Tracker # _____
3	• Order Materials for installation	
4	•Write SWI and JHA for Beta Test	
5	•Install beta test on site	
6	•Document install	

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Change Benefits

Area	Benefit
Cost	• [REDACTED] • Cost savings achieved on reduction of materials. • Additional savings will be achieved via reduced shipping costs • Additional labor savings
Productivity	• Quicker installation

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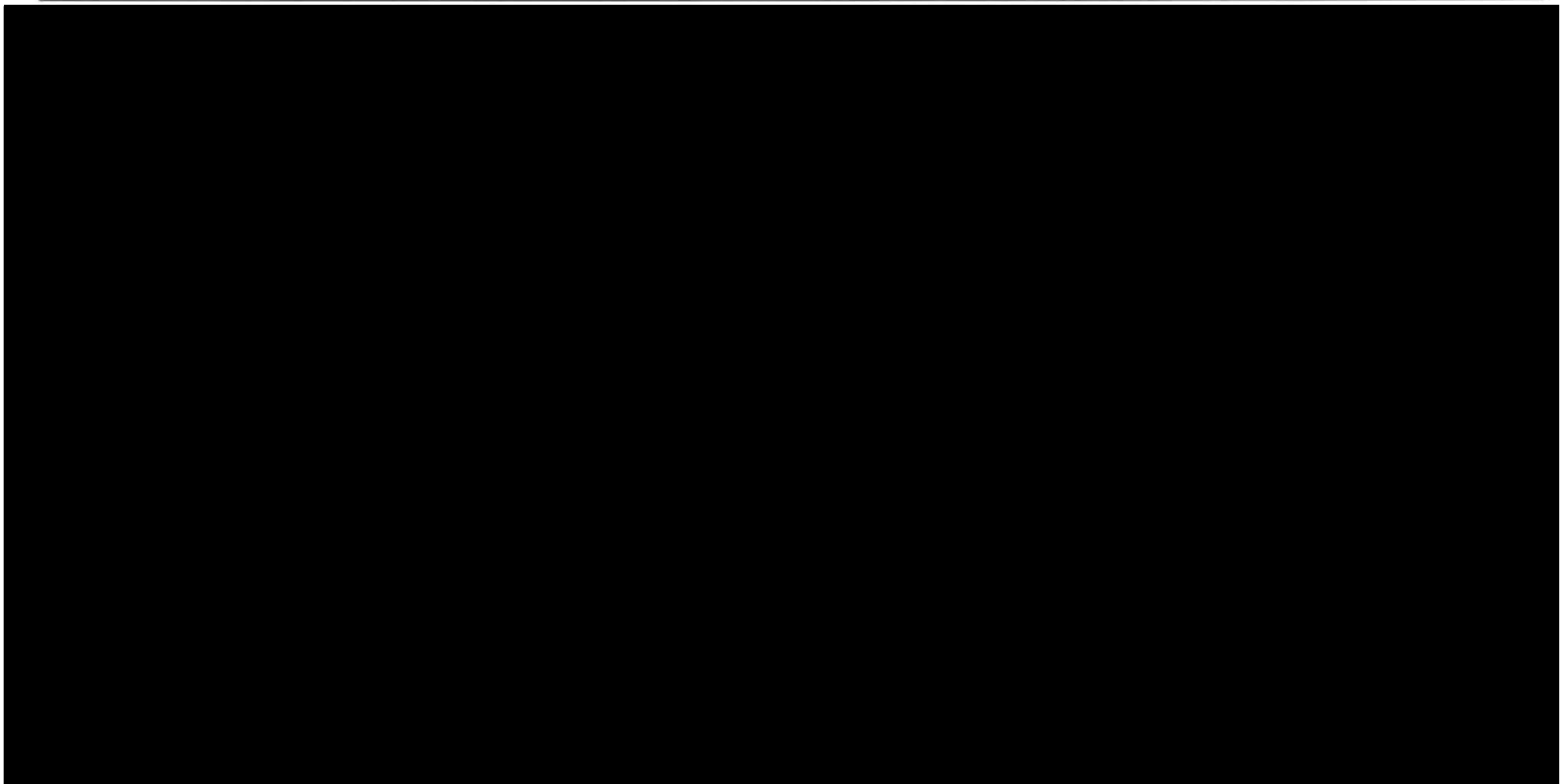
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Projected Results: NPV & ROI



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Risk Analysis

#	KEY RISK	MITIGATION	REMARKS	ROI
1	[REDACTED]	[REDACTED]	[REDACTED]	
2	[REDACTED]	[REDACTED]	[REDACTED]	
3	[REDACTED]	[REDACTED]	[REDACTED]	
4	[REDACTED]	[REDACTED]		
5	[REDACTED]			
6	[REDACTED]	[REDACTED]		
7	[REDACTED]	[REDACTED]		
8	[REDACTED]	[REDACTED]		

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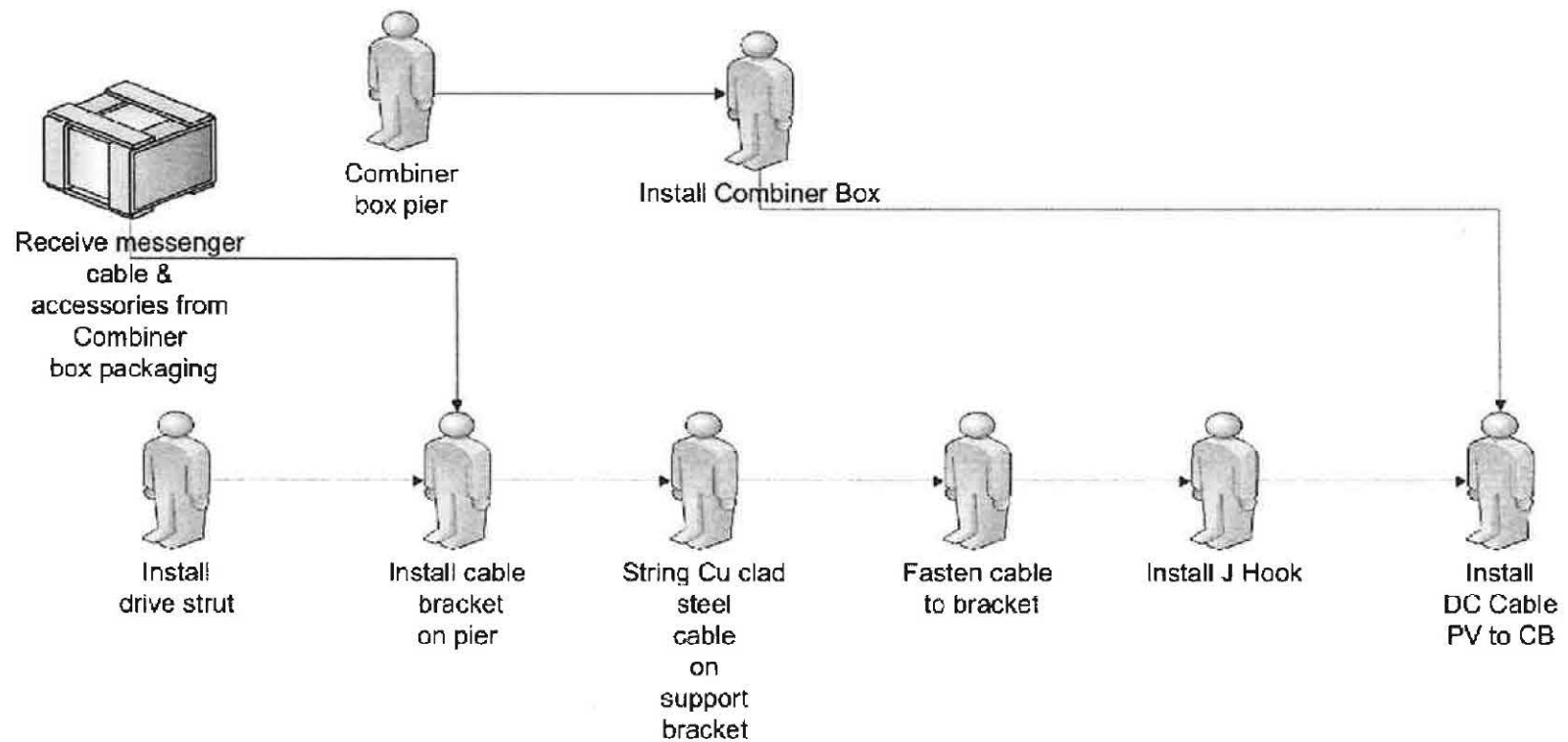
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Change Description Details

MESSENGER CABLE WORK FLOW DIAGRAM



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Key Impacts/ Target Metrics

INDICATOR	NO CHANGE	INCREASE	DECREASE	REMARKS
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]

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FPCR Process Timeline

- Review FPCR-0 WW04 2013
- Review FPCR-1 WW10 2013
- Review FPCR-2 WW20 2013
- Review FPCR-3 TBD

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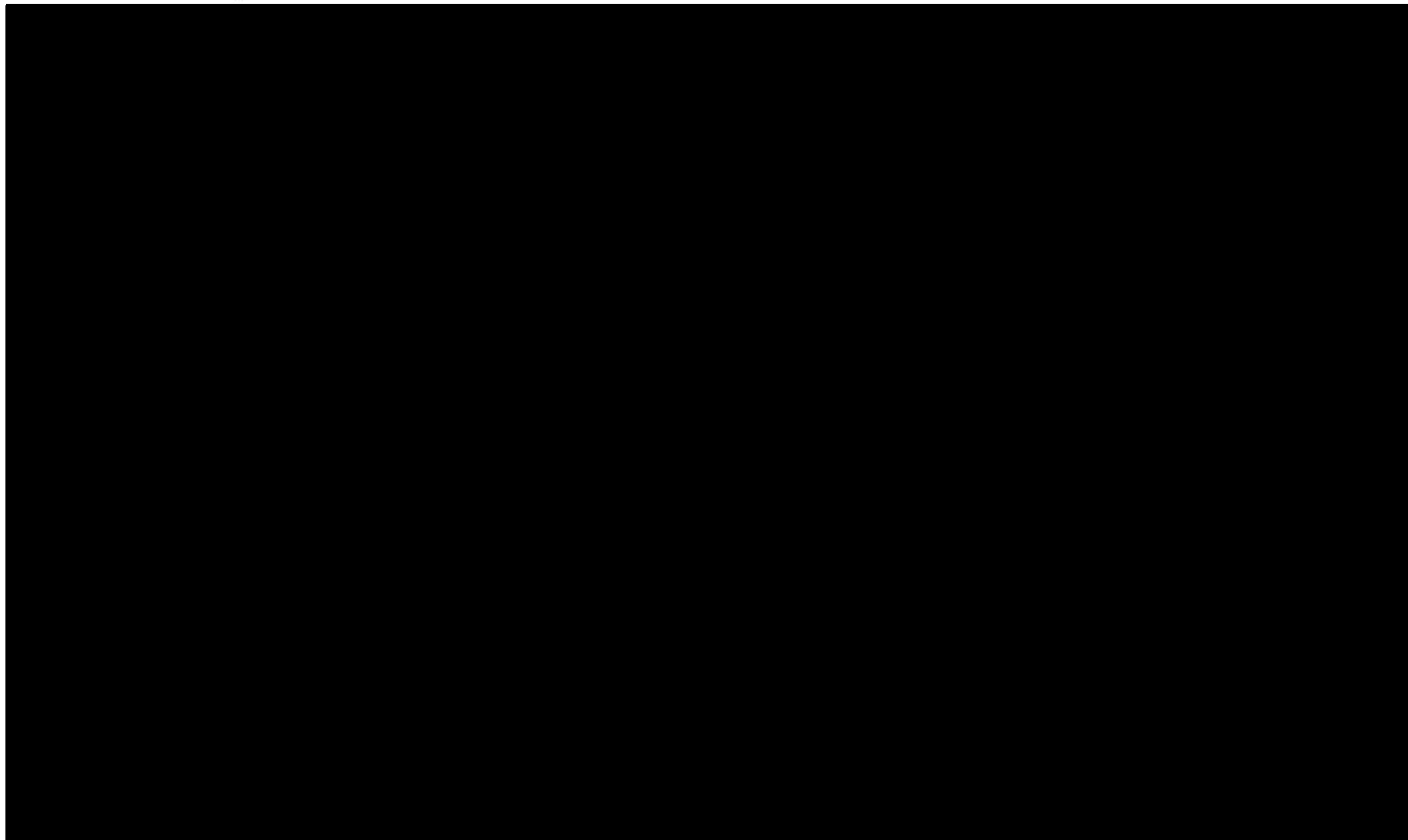
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AR Requirements/Status



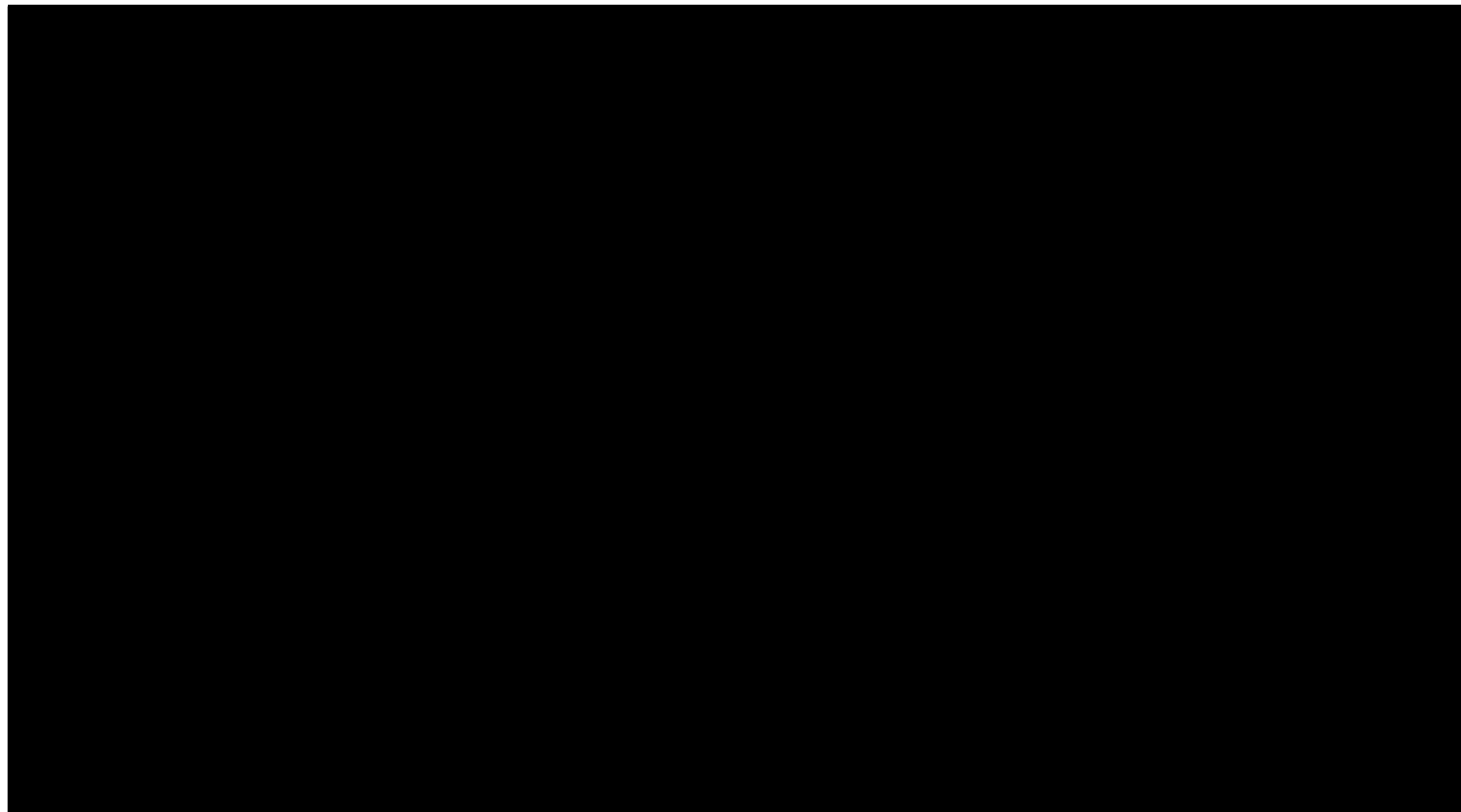
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Resource Requirements



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Standard Work Instructions - Drafts

ARENA #	#	List Relevant SW's and note new QC Inspection and Job Hazard Analysis (JHA) included.	New QC	New JHA
	1			
	2			
	3			
	4			
	5			
	6			
	7			
	8			
	9			
	10			
	11			
	12			
	13			
	14			

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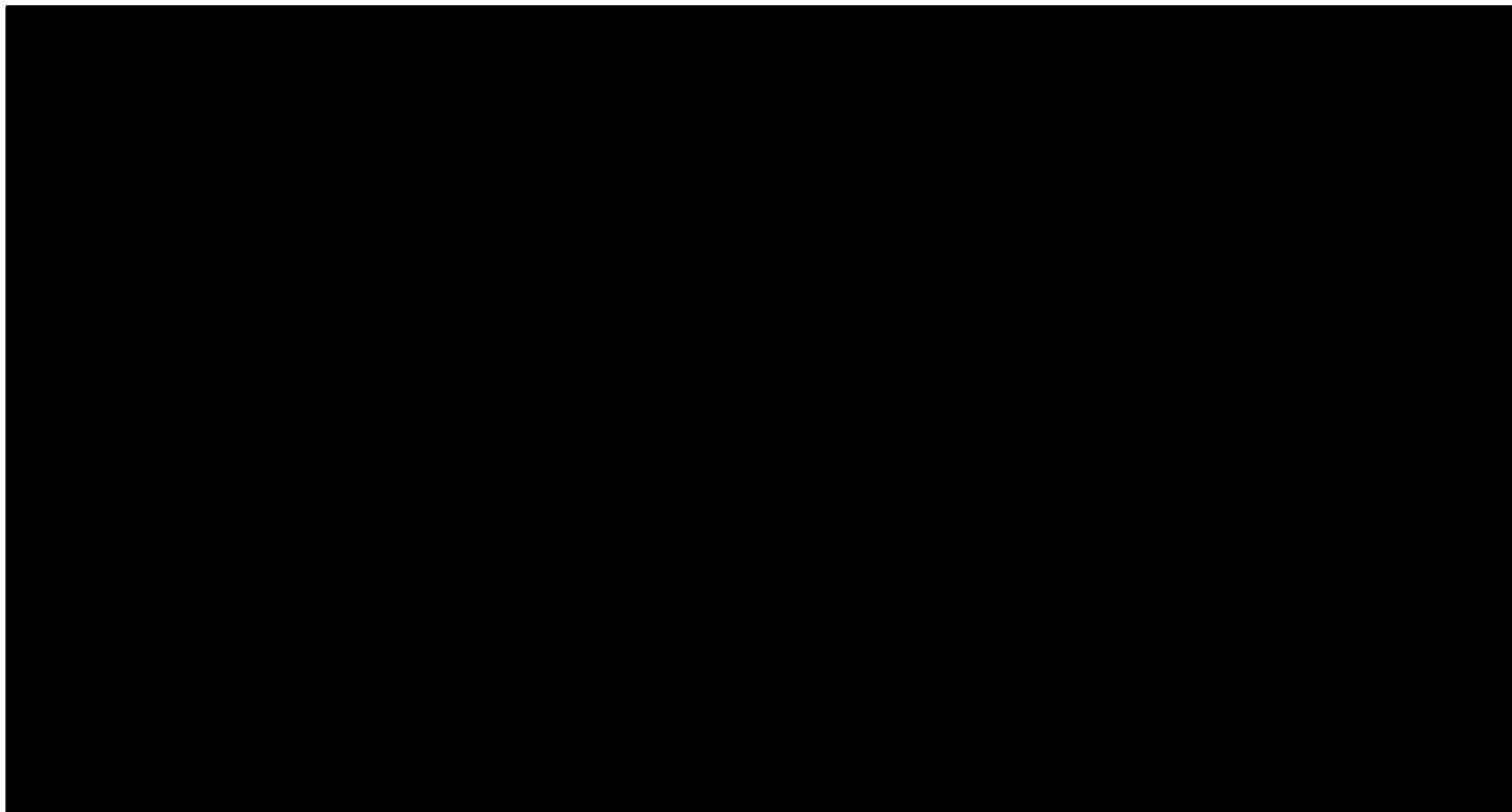
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SWI and JHA

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Documents Affected

DMS #	ARENA #	#	Document Title	Sections impacted	Remarks
		1			
		2			
		3			
		4			
		5			
		6			
		7			
		8			
		9			
		10			
		11			

Indicate relevant DMS/ARENA controlled documents affected by the change.

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Development Results and Recommendation

- Provide narrative summary of development work, findings and recommendation for next steps (Beta test or plan revisions).
- How has development work impacted plan: Provide updates in subsequent slides to “AR’s”, “Key Impact metrics”, “Resource Requirements”, “Documents Affected”, “SWI’s” required.
- Recommendation to perform Beta Test (or not)
- Beta Test Plan Summary Plan – details: who, how, when, where beta test to be performed.

Summarize AR status and findings. Highlight changes to Planning phase in summary here (subsequent slides allow detailed plan descriptions). Provide Beta Test recommendations.

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Development Review Update

Provide Development phase results and update slides for:

- Key impacts/target metrics
- Risk analysis
- Resource requirements
- AR Requirements/status
- SWI status
- Documents affected

Update Metrics and Impacts based on new information or changes required from Development work.

Use as many slides as needed.

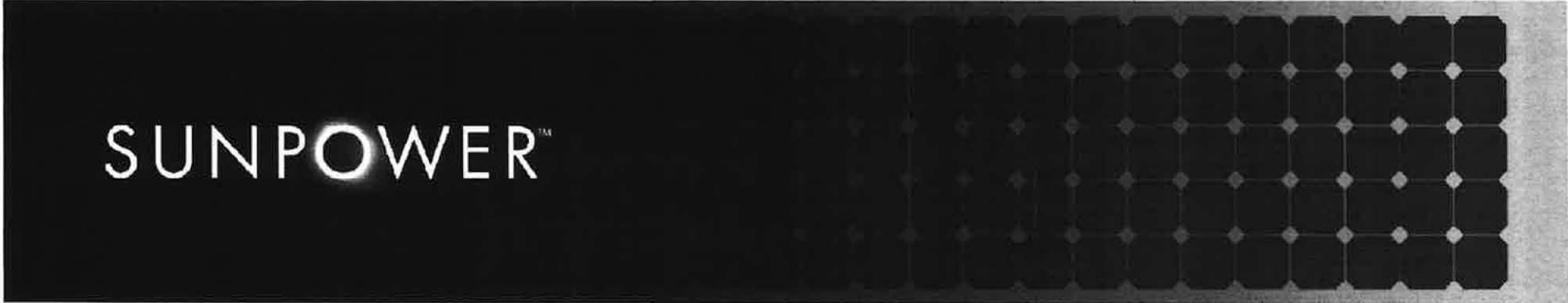
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Appendix

Optimization (Beta test) Review

- Provide narrative summary of Beta test results, findings and recommendation for next steps. Indicate if new procedures are fully optimized or if additional cycles of learning are required. Recommend if ready for ECO and standardization of affected documents and SWI's. Provide recommendation for Quality Check requirements
- Provide updates in subsequent slides to “AR's”, “Key Impact metrics”, AR's to include ECO actions to update Documents, finalize SWI's.
- Provide recommended Quality Check follow-up Plan – details: who, how, when, where.

Summarize AR status and findings. Highlight key metrics actuals vs target in summary here (subsequent slides allow detailed plan descriptions). Provide follow-up recommendations

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Optimization Review Update

Provide Beta test and optimization results and update slides for:

- Risk analysis
- Resource requirements
- AR Requirements/status
- SWI status
- Documents affected

Update Risk analysis, resource requirements, AR's, SWI's and documents lists based on new information or changes required from Development work.

Use as many slides as needed.

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Key Impacts / Results - Update Actual vs Target

INDICATOR	NO CHANGE	INCREASE	DECREASE	CHANGE FROM PLAN
Productivity	x			
Field Direct Cost	x			
Schedule	x			
COPQ	x			
Capacity/Production (MW/MW-hrs)	x			
Quality	x			
Material Cost	x			
Delivered Product				
Compare actual results to target metrics and impacts based on optimization work and Beta test.				
Ir				Use as many slides as needed.
Safe				** DELETE THIS BOX **
External Customer	x			

QUALITY Check Phase –

Test Plan

- IS Quality Check Required?: Yes / No
- Due Date:
- Quality Check Owner:
- Description of Inspection Requirements:
- Monitoring period (or number of cycles) or production volume to be monitored:
- Acceptance criteria:
- Analysis method:

Define Quality Check requirements – when, who, how, how long, pass/fail criteria, methods

Use as many slides as needed.

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Quality Check Review

- Provide narrative summary of final Quality check on Beta and subsequent installations, findings and recommendation for next steps or improvements, if any. Indicate if new procedures are fully optimized or if additional cycles of learning are required. Recommend if ready for standardization of affected documents and SWI's.
- Provide updates in subsequent slide to "AR's", "Key Impact metrics", AR's to include ECO actions to update Documents, finalize SWI's.
- Provide recommended Quality Check follow-up Plan, if needed – details: who, how, when, where.

Summarize QC findings. Highlight key metrics actuals vs target in summary here (subsequent slides allow detailed plan descriptions). Provide follow-up recommendations

TIAL

Quality Check Review Update

Provide Quality Check results and update slides, if needed for:

- Key impacts/target metrics
- Risk analysis
- Resource requirements
- AR Requirements/status
- SWI status
- Documents affected

Update Metrics and Impacts based on new information or changes.

Use as many slides as needed.

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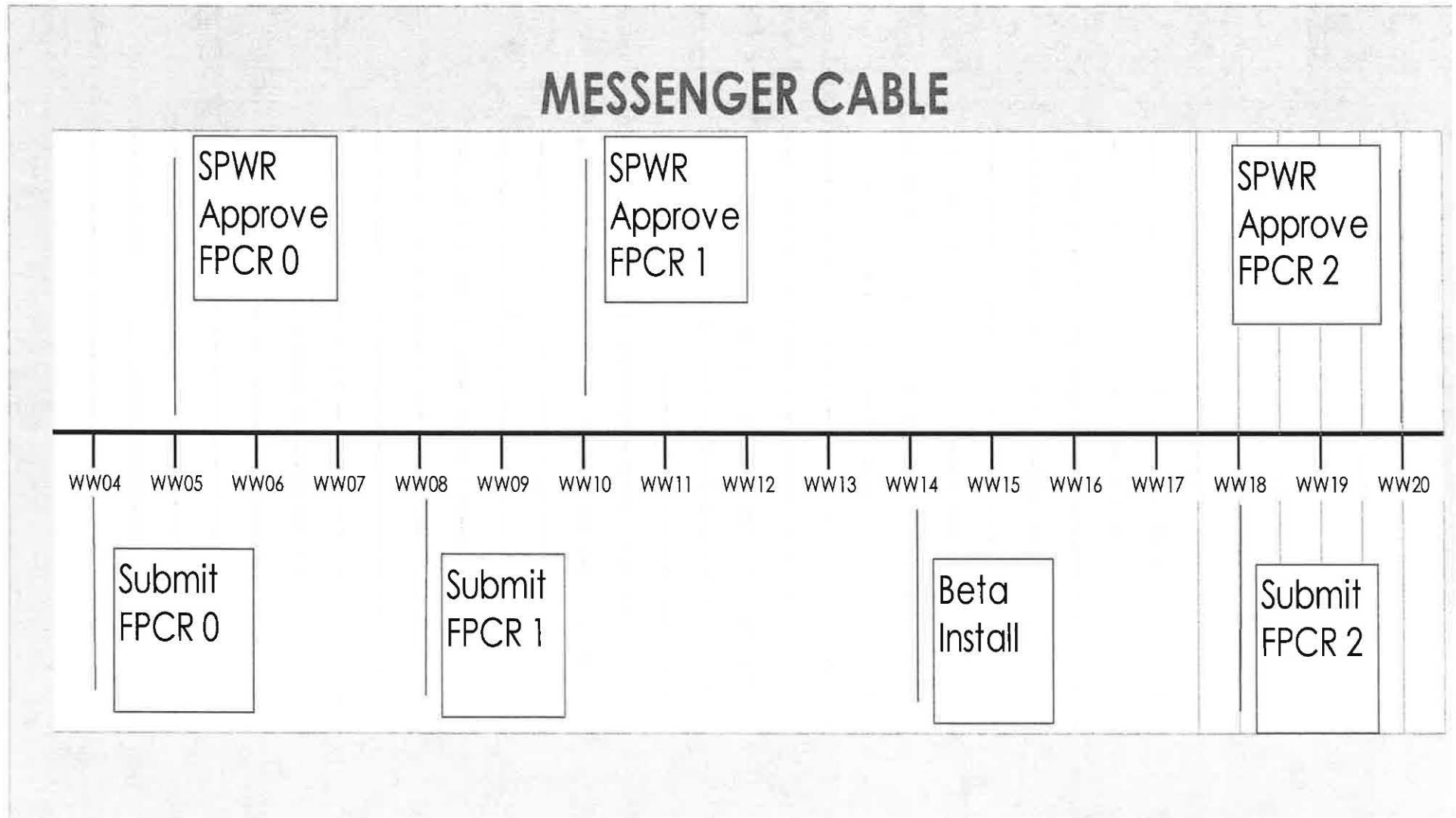
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Post Quality Check Recommendations

AR #	What	Who	When	Status	Comments
	List AR's for QC Follow-up or revisions to original procedures. ** DELETE THIS BOX **				

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FPCR Process Timeline



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Risk Analysis

#	Key Risk	Mitigation	Remarks
1	Customer quality perception	Sales training to inform customer	Lower cost for repair or replacement
2	Acceptance by Independent engineer	Review by in house engineer for code compliance	Ask peers
3	Acceptance by AHJ	Review by in house engineer for code compliance	CAB could help prove code compliance
4	Availability of parts to connect to piers	Research available parts	
5	See FMEA risk in Appendix		
6	Grounding for string wire may be required	Perform engineering analysis	
7	UL listing may be required for connections including grounding	Perform engineering analysis	

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Change Description Details

PROPOSED CHANGE:

- The scope of this FPCR is to obtain approval to proceed with the design and procurement of materials to furnish and install a cable support system to carry the String Wiring for the Oasis v2.0 product.
- The current process includes the furnishing and installation of an aluminum cable tray.

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Change Description Details

PURPOSE OF THIS CHANGE:

- The messenger cable will:
 - Save money
 - Lower cost of the cable tray material and shipping
 - Increase installation speed
 - Material is lighter
 - Less pieces required

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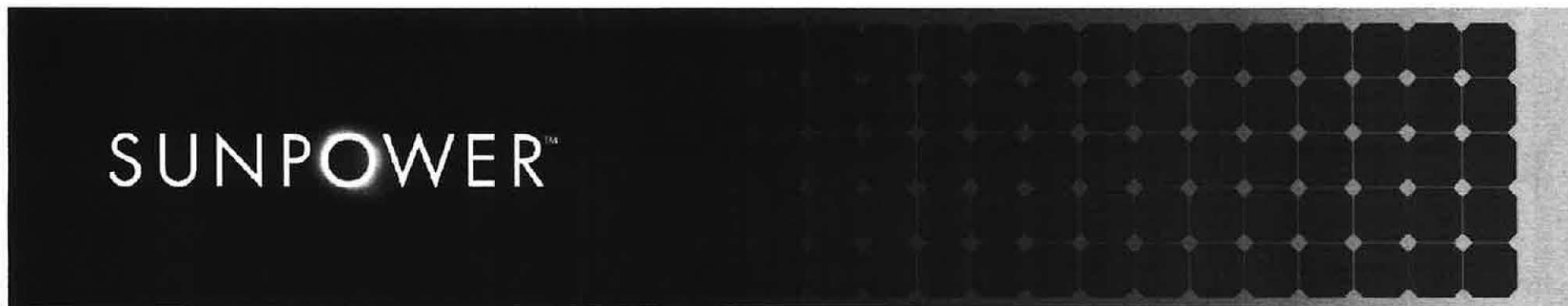
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Failure Modes and Effects Analysis (FMEA)

The SunPower Way



Messenger Cable

Jan 2013

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Glossary of Terms

- **Boundary Diagram:** An illustration or diagram that represents the scope of the FMEA, including interfaces. The boundary diagram is typically employed in a Design FMEA. Previously referred to as a block diagram.
- **Cause:** A Cause is the means by which an element of the design or process results in a Failure Mode.
- **Critical Characteristic:** A product or process parameter that can affect compliance with legal and/or regulatory requirements, or has a significant impact on form, fit or function.
- **Criticality:** The Criticality rating is the mathematical product of the Severity and Occurrence ratings. The criticality value is used to place priority on items that require additional quality planning. Criticality is typically a term employed in the automotive industry.
- **Current Controls:** Current Controls (design and process) are the mechanisms currently in place that prevent the Cause of the Failure Mode from occurring, or which detect the failure before it reaches the Customer.
- **Customer:** Customers are internal and external departments, people, and processes that will be adversely affected by product failure. This could include the next step in line, the field service technician, or the end customer.

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Glossary of Terms

- **Detection:** Detection is an assessment of the probability that the Current Controls (design and process) will detect the Cause of the Failure Mode or the Failure Mode itself, thus preventing it from reaching the customer.
- **Effect:** An effect is an adverse consequence that the customer might experience.
- **Failure:** Inability of an item to perform it's intended function.
- **Failure Mode:** Failure Modes are sometimes described as categories of failure. A potential Failure Mode describes the way in which a product or process could fail to perform its desired function (design intent or performance requirements) as described by the needs, wants, and expectations of the internal and external Customers.
- **FMEA Element:** FMEA elements are identified or analyzed in the FMEA process. Common examples are Functions, Failure Modes, Causes, Effects, Controls, and Actions. FMEA elements appear as column headings in the output form.
- **Occurrence:** Occurrence is an assessment of the likelihood that a particular Cause will happen and result in the Failure Mode during the intended life and use of the product.

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Glossary of Terms

- ***Risk Priority Number:*** The Risk Priority Number is a mathematical product of the ratings for Severity, Occurrence, and Detection ratings.
 $RPN = (S) \times (O) \times (D)$. This number is used to place priority on items that require additional quality planning. RPN ratings range from 1 (all factors being 1) to 1000 (all factors being 10).
- ***Secondary Function:*** A function of the product that secondary to, but supportive of, the primary function.
- ***Severity:*** Severity is an assessment of how serious the Effect of the potential Failure Mode is on the Customer.
- ***Voice of the Customer (VOC):*** Feedback obtained directly from the customer on their needs, wants and expectations.

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Failure Modes and Effect Analysis

FMEA Defined

The systematic and dynamic process of defining, measuring, managing and reducing failures in a system, product, process or service.

Key Words:

- *Systematic Process (step-by-step approach)*
- *Dynamic (FMEA's evolve as the design and process evolves)*
- *Defining (Process Mapping/Functionality Requirements)*
- *Measuring (Key Metrics)*
- *Managing (Analysis, Coordination, Improving)*
- *Applies to systems, products (design), processes or services*

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Process FMEA Methodology

Process FMEA Step-by-Step

Step 1: Define Scope of Process FMEA

Step 2: Select the Team

Step 3: Define Process/Function

Step 4: Define Failure Mode and Effect

Step 5: Calculate Risk

Step 6: Recommend Actions to be Taken

Step 7: Verify Effectiveness of Actions Taken

Step 8: Evaluate Need for Further Actions

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Step 1: Define the Scope of the Design FMEA

The scope of this Design FMEA includes design, equipment, materials and process to furnish and install a cable support system to carry the DC wires in the trackers in lieu of using a cable tray system.

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Step 2: Team

Project's Cross-Functional Team:

<u>Name</u>	<u>Position</u>	<u>Team Roles</u>
W. Wilson		Leader
_____	Safety	Sponsor
_____	QC	Sponsor
_____	Products	Sponsor
_____	Design	Sponsor
_____	Construction	Sponsor

Ground rules

- Keep commitments, promises made-promises kept.
- All inputs to the team are valued.

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Step 3: Defining the Process and Function

- The objective of the messenger cable is to provide cost savings and a quicker installation method for supporting the DC cables in the tracker in lieu of using the existing cable tray.
- The current process includes installing a costly aluminum cable tray on the piers. Then DC cables are installed in this tray and connected to the PV panels.
- The new method would consist of installing a small cable on the piers, j hooks (or similar support) and then hang the wires from the supports.
- List various operations (See flow diagram)
- “What is the process supposed to achieve?”
 - Cost savings
 - Manhour reduction

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Step 3: Defining Process / Function Examples

Process functions:

Existing process

- Ship cable tray to project
- Install cable tray on piers
- Install DC cable
- Strap cable to tray
- Connect to PV and Combiner box

Central PV installation

- Ship cable to project
- Install messenger cable on piers
- Install J-hooks (or similar)
- In DC cable
- Connect to PV and Combiner box

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CPI Tools – SIPOC Analysis

SIPOC Analysis

SIPOC Analysis is the method of defining a process in context of the processes inputs and outputs and it's suppliers and customers.

The 5 components of a SIPOC and an explanation of these parts are provided below:

Process Suppliers: A listing of who is providing the process inputs.

Process Inputs: What does a process need to be able to be performed. This may include process documentation, materials, equipment and information.

Process: The steps to use the process inputs to create the process outputs.

Process Outputs: What a process produces. This may include a transformed product, information and/or documentation.

Process Customers: The recipient of the process output. Note, the customer may be internal or external.

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SIPOC Analysis

Input-Output Process Model		
Suppliers, Both Internal and External Cable tray supplier _____ J Hook supplier _____ Messenger cable supplier _____	Process Furnish and Install messenger cable (See Messenger cable Flow Diagram)	Outputs from the Process Cable DC support system
Inputs to the Process Engineering of cable Code acceptance J-hook supports Messenger cable Re draw FA sheets		Customers, Both Internal and External Quality Control Electrical installer SPWR Construction SPWR Safety SPWR Engineering
Process Metrics to Measure Process Outputs: Manhours per tracker block installed Cost of material and shipping		

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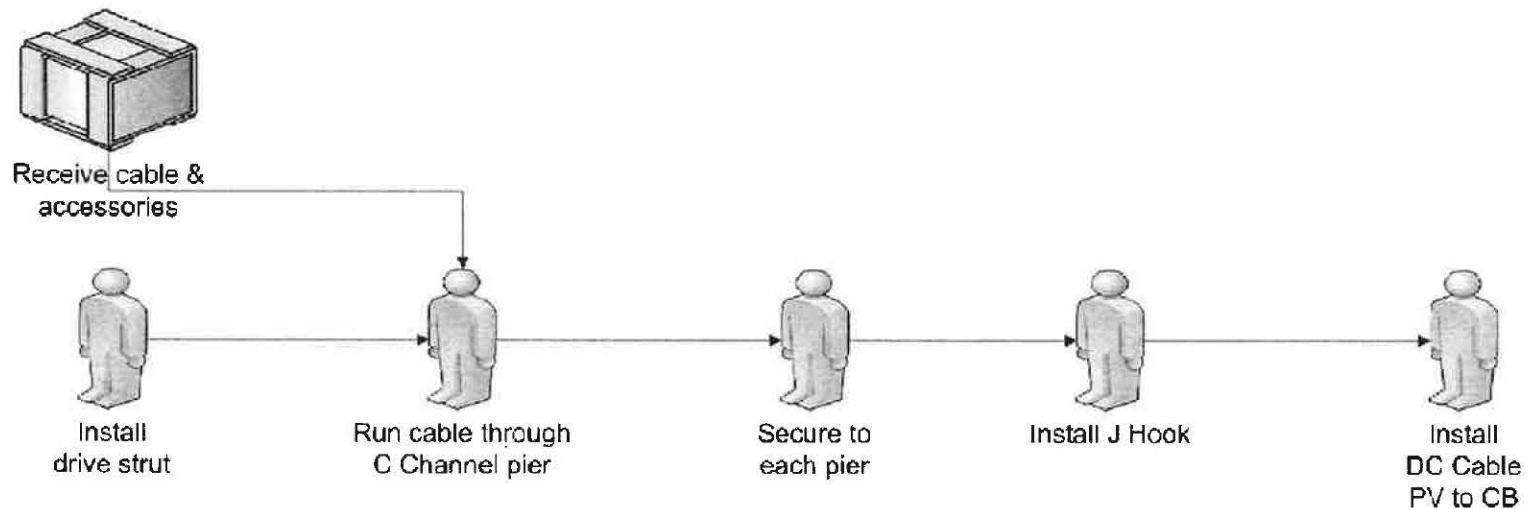
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Flow Chart of Messenger Cable Installation

MESSENGER CABLE WORK FLOW DIAGRAM



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Step 3: Defining the Process Function Key Requirements

For assigned process steps, define the requirement, the source of the requirement, and a definition of Key requirements and the rationale for being key.

<u>Process Step</u>	<u>Purpose</u>	<u>Key?</u>
1. Design accessories	Choose proper accessories	Yes
2. Price accessories	Ensure they will work	Yes

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DFMEA Messenger Cable

Design Failure Mode and Effects Analysis (DFMEA)				Prepared by:		Approved by:		Acknowled						
Device Name:		Product Type:		FMEA Date (Orig.):		FMEA Date Released:								
Item:		Design Responsibility:		Revision:		FMEA (Spec) Number:								
FMEA Team:				FMEA Date Conducted:		Page ____ of ____								
Feature Description	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Potential Cause(s)/ Mechanism(s) of failure	Occ	Current Design		Detect	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Result		
						Prevent	Detect					Actions Taken	Sev	Occ
Cable	AHJ won't accept	Cable rejected		Failed to gain prior AHJ approval					0					
	Engineer won't accept	Cable rejected		Failure to gain prior Eng approval					0					
	Heat/cold affects install	Expansion pulls on piers		Construction installed improperly					0					
									0					
									0					
Cable Hangers	Quantity unavailable	fail to meet schedule		Factory capacity not known					0					
									0					
									0					
									0					
									0					
Cable attachments	Too high priced	System too costly		Not researched					0					
									0					
									0					
									0					
									0					

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Step 4: Define Potential Failure Modes and Effects

The potential failure mode is defined as the manner in which processes could fail to meet process requirements or the design intent. When considering a potential failure mode, it is important to frame the failure in terms of failure to meet requirements (specifications).

There are 5 major categories of process failure modes:

1. Product is rejected at test.
2. Problem in assembly that causes the function to not be completed.
3. Parts rejected at receiving inspection (or next process step)
4. Defects caught in manufacturing (dimensional, cosmetic, design characteristics not met) causing rework or scrap.)
5. Product fails in customer usage.

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Step 5 – Calculate Risk

To calculate risk we will need to understand the severity of the failure mode, the frequency of occurrence and the likelihood that the failure will be caught before it gets to the customer. The Risk Priority Number (RPN) is calculated by taking the product of severity, occurrence and detection.

$$\text{Severity} \times \text{Occurrence} \times \text{Detection} = \text{RPN}$$

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Severity Rating Process – Customer Effect

Below is the **SunPower** rating scale used for severity as related to customer effect.

<u>Severity</u>	<u>Customer Effect</u>
10	Safety hazard without warning (or govt. regulations) to consumer or installation/maintenance personnel.
9	Safety hazard with warning or 100% product recall.
8	Product failure, loss of function. 100% product recall during installation.
7	Reduced performance. Customer very dissatisfied. Portion of product recalled.
6	Machine operable but products inoperable. Cosmetic defects obvious out of box, customer dissatisfied, but no recall.
5	Comfort/convenience items reduced. Customer somewhat dissatisfied.
4	Cosmetic items noticed by most customers.
3	Cosmetic defects noticeable to half the customers.
2	Cosmetic defects noticeable to most discerning customers.
1	No discernible effect.

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Severity Rating Process – Manufacturing Effect

Below is the **SunPower** rating scale used for severity as related to manufacturing/assembly effect.

<u>Severity</u>	<u>Productivity Loss</u>
10	Results in safety loss
9	>1 shift operation downtime
8	>10 to 12 hours
7	8 to 10 hours
6	6 to 8 hours
5	4 to 6 hours
4	2 to 4 hours
3	1.5 to 2 hours
2	.75 to 1.5 hours
1	< .75 hours

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Severity Rating Process – Productivity Loss

The team will need to define the rating scale that will be used. Below is an **example** rating scale used for severity as related to manufacturing/assembly effect.

<u>Severity</u>	<u>Manufacturing Effect</u>
10	May endanger operator without warning.
9	Endanger operator with warning. Reliability problem.
8	100% product failure.
7	Product 100% sorted and some product scrapped.
6	Some product scrapped without 100% sorting.
5	100% of product reworked.
4	100% product sorted with rework but no scrap.
3	Part of product may be reworked off line with no scrap.
2	Part of product may be reworked at work station.
1	No discernible effect.

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Defining Potential Causes

Using knowledge of the process, teams identify potential cause of the failure mode. The team should focus here on what they believe the root cause(s) are likely to be. Process knowledge is extremely important in this step. It is likely that there will be more than one potential cause for a specific failure mode. Be sure to be as comprehensive as possible when listing the potential causes.

Potential Tools to define potential causes:

- Process Map Analysis
- Ask the “5 Why’s”
- Fault Tree Analysis
- Cause and Effect Analysis

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Determine Occurrence Rating

It will be important to apply a ranking in terms of occurrence. The occurrence will be based on the frequency of the cause occurring. In cases where data is not available, data from similar processes may be utilized. Design of Experiments may be used to determine relative frequency of occurrence of various suspected root causes.

When considering occurrence, consider the following sources of data:

- Consider the use of Cpk data
- Attribute data (c chart or p chart)
- Consider maintenance data (Mean Time Between Failures-MTBF)
- If no data is available, subjective criteria may be used. (Least desirable, but sometimes necessary)

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Occurrence Rating Process - Example

The team will need to define the rating scale that will be used. Below is an **example** rating scale used for occurrence.

<u>Occurrence</u>	<u>Probability</u>	<u>Likely Failure Rates</u>
10	Persistent failures.	337,000 ppm
9		322,200 ppm
8	Frequent Failures	126,000 ppm
7		44,400 ppm
6	Occasional Failures	12780 ppm
5		2700 ppm
4		466 ppm
3	Low Failure Rates	63.4 ppm
2		6.8 ppm
1	Failure Unlikely	Less than 1 ppm

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Detection Rating Process - Example

The team will need to define the rating scale that will be used. Below is an *example* rating scale used for Detection.

<u>Detection</u>	<u>Customer Effect</u>
10	Absolutely will not be detected. Cannot be detected.
9	Controls will probably not detect. Weekly monitoring but no prevention.
8	Controls have poor chance of detection. Visual inspection only.
7	Controls have poor chance of detection. Double visual inspection only.
6	Controls may detect. SPC in place.
5	Controls may detect. 100% product checked.
4	Controls have a good chance to detect. First piece check in place.
3	Controls have a good chance to detect. Error detection in next station.
2	Controls almost certain to detect. Error detection in station.
1	Controls certain to detect. Error proofing in place.

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Step 6 – Recommend Actions to be Taken

Once the team has identified the causes that are most significant, it is time to consider action. The team brainstorms potential actions that can result in reducing ratings related to severity, occurrence and/or detection.

Guidelines for Action:

- No FMEA should be undertaken without a consideration of action to be taken.
- Brainstorm actions to be taken using appropriate problem solving tools.
- Identify recommended actions and proposed responsibility and due dates.
- If the decision is to take no action, record this on the action plan.

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Step 7 – Verify Effectiveness of Actions Taken

Record the actual actions taken. If the recommended action is considered to be too costly, then record the alternate action that is actually taken. Based on the analysis, record the new RPN based on adjusted ratings on severity, occurrence and detection.

- Be sure to update the revision of the Process FMEA.
- Verify improvements with actual data. Ensure that the described actions have been properly implemented.
- Consider the impact that a change will have on other parts of the process.
- Add increased inspection as a last resort only. Inspections are costly, time consuming and not 100% accurate. Focus should be on prevention, not detection.
- Record keeping establishes a baseline for each process selected. This can be used for trouble shooting in the future as personnel change and the process evolves.

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Step 8 – Evaluate Needs for Further Actions

The FMEA process is a process of continuous improvement. Data from the Process FMEA should be periodically reviewed for new opportunities for improvement. Application of improvements may be considered as inputs for other process analysis.

To bring the team to closure, consider the following tasks:

- Present the results of the Process FMEA to management and peers.
- Quantify improvements, in terms of defects, cost, customer satisfaction.
- If actions addressed a certain threshold, consider a lower threshold for further action.

Remember, even though an FMEA is a living document, the FMEA team is not a forever team. Remember to recognize the team and bring it to closure.

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