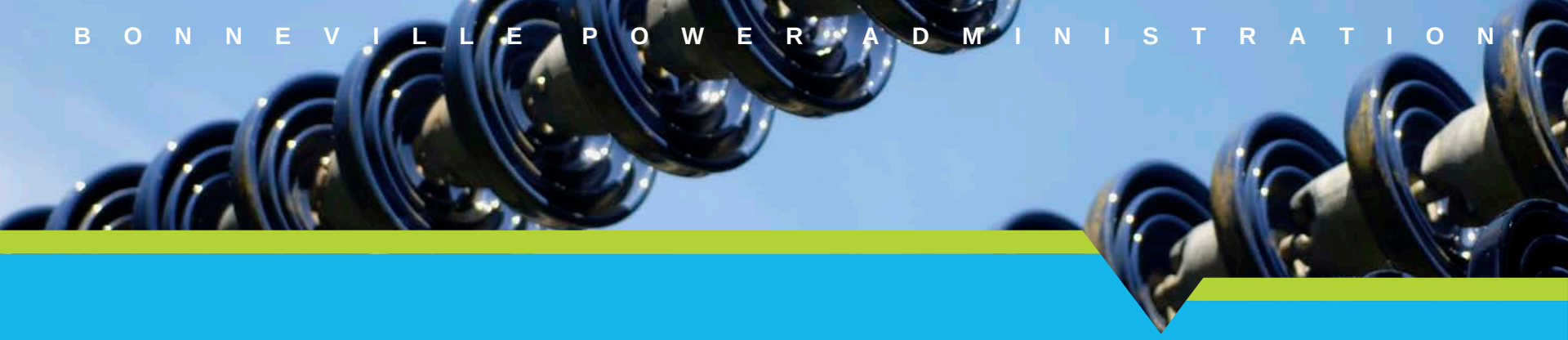


Steel Lines

Sustain Program

Asset Management Strategy

Corinn Castro, Program Manager

March 2012

Executive Summary

- **Situation Assessment**
  - Sixty percent of BPA's 10,660 circuit miles of steel lines are 40 years or older and many still have the original hardware in place.
  - Theoretical life expectancy of the most critical active components is 40 years.
  - In the period between 2005 and 2011, BPA experienced 41 outages in excess of 240 minutes that were due to material failure.
  - The advanced age of components is assumed to increase their likelihood of failure during severe weather.
  - BPA is experiencing material failures that indicate that active components (connectors, insulators, dampers, spacers, airway warnings) have a finite lifespan and are approaching that limit; reliability and availability of the operating line will decrease as a result.
  - Failing components could result in extended line outages and possibly a multiple line outage if a span crossing over other lines fails.
  - BPA needs to be proactive in addressing these aging assets and avoid being in a reactive mode with regard to transmission line material failure.
  - Maintenance costs to repair or replace failing components in a piece meal fashion will be less cost effective than a proactive and methodical component replacement approach.

What equipment and facilities are covered?

What performance objectives, measures and targets should be set?

What is the health of the assets, and what risks must be managed?

What strategies should BPA undertake?

What will it cost?

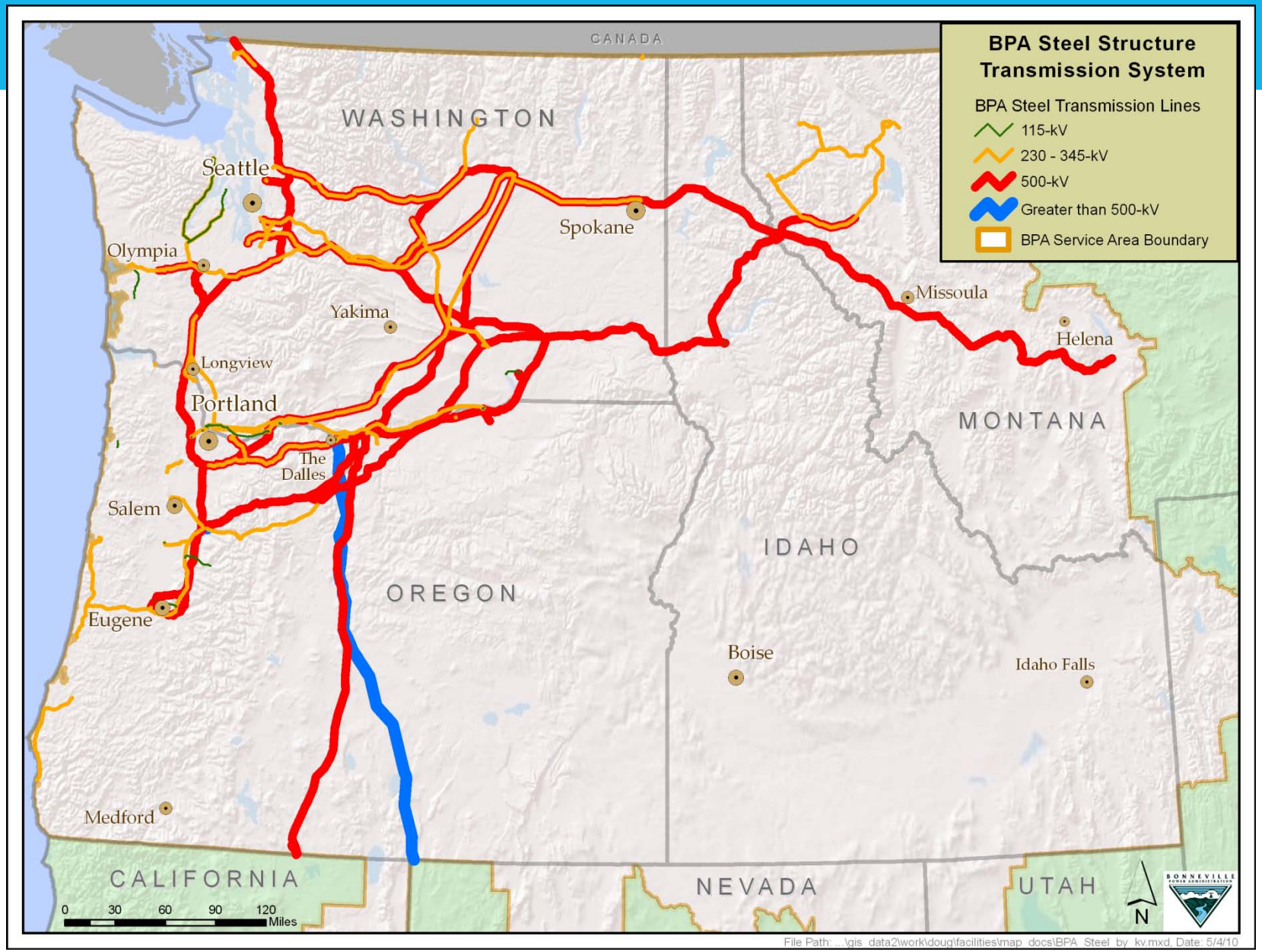
Program Accomplishments to date.

Assets and Asset Systems

BPA's Steel transmission lines consists of about 10,660 circuit miles on approximately 43,000 steel lattice towers, steel lattice poles and engineered steel poles. This includes the DC intertie (~260 circuit miles,) all of the 500kV grid (~4900 circuit miles including the AC interties,) along with about 80 percent of the 230- 345kV system (~4900 circuit miles) and about 13 percent of the 115kV system (~600 circuit miles.)

- Assets consist of:
  - Lattice Towers
  - Lattice Poles
  - Engineered Steel Poles
  - Footings: Concrete Pier, Rock, Grillage, Plate, Pile
  - Guying Systems: Guy anchors, Rods, Guy Strands, Guy Insulators
  - Conductor: AAC, AACTW, ACSR, ACSRTW, Copper, Specials
  - Conductor Insulators assemblies and associated hardware: Insulator string (Ceramic, glass, NCI), Suspension shoes, Armor rod, Vibration dampers, Jumpers and jumper attachment hardware, Shunts
  - Spacers and Spacer Dampers
  - Ground Wire and Associated Hardware
  - Airway Warning: Lighting, Marker Balls

- Asset systems consist of:
  - Network critical transmission lines
  - Interties
  - Key points of interconnection with many of BPA's load serving wholesale full and partial requirements customers


BPA Steel Structure Transmission System
BPA Steel Transmission Lines
115-kV
230 - 345-kV
500-kV
Greater than 500-kV
BPA Service Area Boundary
CANADA
WASHINGTON
Seattle
Spokane
Olympia
Yakima
Missoula
Helena
Longview
Portland
The Dalles
MONTANA
Salem
IDAHO
OREGON
Eugene
Boise
Idaho Falls
Medford
CALIFORNIA
NEVADA
UTAH
0 30 60 90 120 Miles
N
File Path: ...\gis_data2\work\doug\facilities\map_docs\BPA_Steel_by_kv.mxd, Date: 5/4/10

Criticality of Assets and Asset Systems

- 230kV and 500kV steel lines are category 1 or 2 (the most critical) and 115kV steel lines are mostly category 3 or 4.
- Operations has identified a subset of the category 1 & 2 lines, which are determined to be extremely critical and for which planned and unplanned outages are highly undesirable and becoming more so. Line criticality will be confirmed using Transmission's project prioritization criteria.
- Until a more comprehensive database on component condition is amassed, line age, outage history and TLM observation is the basis for characterizing condition.
- A combination of the above will be used to determine the likelihood, magnitude and consequence of a line outage for purposes of assessing risk.

Products and Services Provided

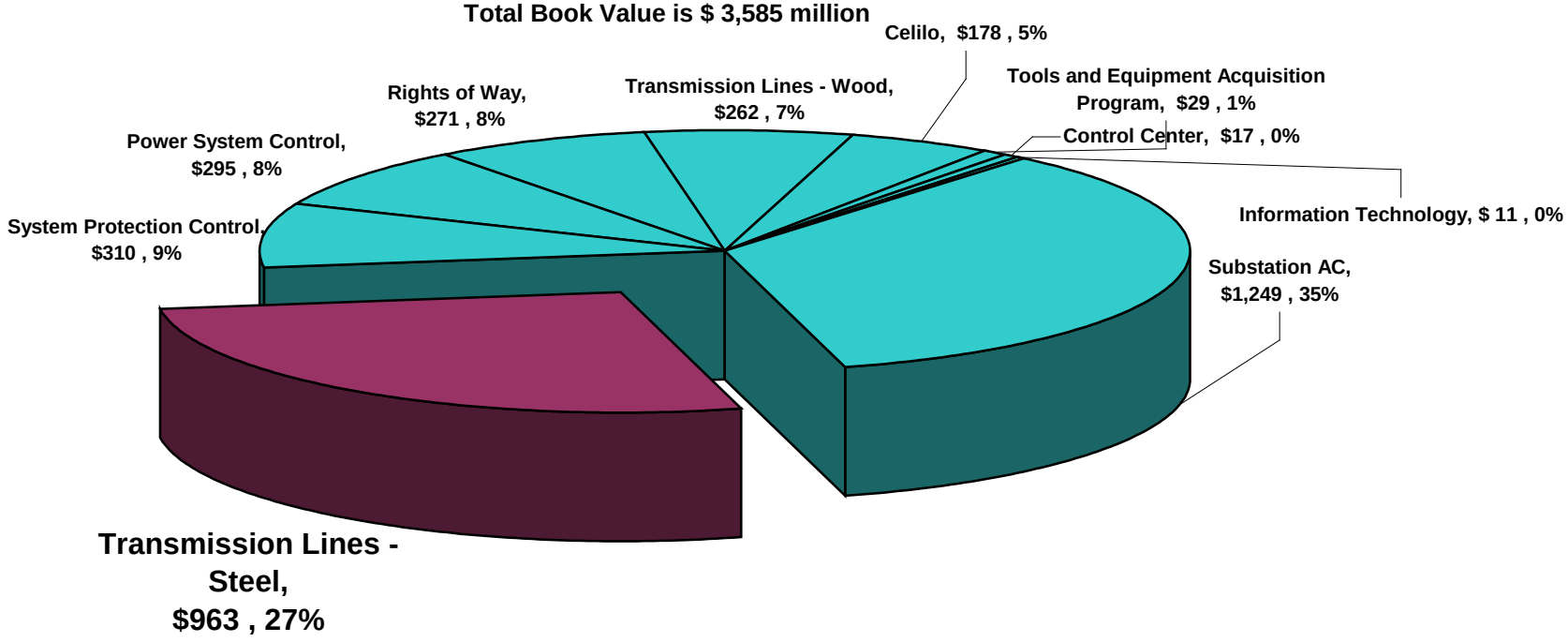
- Customers and Stakeholders Served
  - NW Utility Customers
  - Regulatory Agencies: WECC, NERC, FERC
  - Independent Power Producers, wind generation integration
  - Tribes
  - Private communication network service providers
  - Extra Regional Customers

- Products and Services
  - Network service
  - Generation integration
  - Point to Point Service
  - Intertie Service
  - Communications services for operations of the transmission system and private networks.
  - Area & customer Service

Historical Investment – After Depreciation

Transmission Sustain Programs
Historical Investment After Depreciation
as of Sept. 30, 2011
(in millions)

Total Book Value is $ 3,585 million



Source: BPA Asset Accounting

What equipment and facilities are covered?

What performance objectives, measures and targets should be set?

What is the health of the assets, and what risks must be managed?

What strategies should BPA undertake?

What will it cost?

Program Accomplishments to date.

Performance targets that drive this strategy

Goals for improving asset management practices

Goals

G1 **Transmission asset management practices conform with leading practices.**

G2 **Expansion, replacements, and maintenance are:**

- **Coordinated and integrated**
- **Prioritized to give prompt attention to the most critical assets at greatest risk**
- **Directed at meeting reliability, adequacy, availability and other standards**
- **Directed at minimizing life-cycle costs**
- **Responsive to regional customer needs**

G3 **Asset management plans deliver on the transmission asset management strategy through an optimized funding and resourcing plan. Projects are completed within scope, on schedule and within budget**

Strategic initiatives

S-1. Transmission Services employs a structured management system to evaluate, identify and prioritize areas of improvement for the Asset Management program. The gaps are validated with an independent assessment to be conducted in Q3 of FY12 against Asset Management best practices. Ongoing performance is monitored through the Asset Management operational Dashboard. (G1) Lead: TPR, Support: T, TAMEC, AMS Sponsor Team)

Note: Strategic initiatives for G2 are shown in the Expand and Sustain sections below

S-2. Streamline and integrate business processes and information systems and train the workforce on process changes through selected projects under the Integrated Program and Project Improvement (IPPI) program (within approved scope, schedule and spending targets) (G1, G3) (Business Sponsor: IPPI Team)

- TAS/WPSS – Deliver the Transmission Asset System (TAS Outside-the-Fence) and the Work Planning and Scheduling System (WPSS) Information Technology projects (Lead: T, NJ)
- Project Management Implementation Plan – Improve project management processes and practices and implement the Project Management Playbook (Business Sponsor: TEP)
- Asset Plan Repository/Portfolio Management – Improve processes and tools to, at a minimum, facilitate cross-program prioritization/coordination, effective sequencing/aggregation of work, IPR/OMB financial forecasting (Business Sponsor: TPW)
- Asset Plan and Strategy Development – Develop a more structured, systematic, and integrated approach to formulating Asset Strategies/Plans. (Lead: TPO; Support TPW)
- IPPI Change Management – Implement a robust, integrated change management strategy and plan to promote acceptance and adoption of business process changes and new systems
- Resource Strategies Development – the Strategic Capability Planning Team will develop resourcing strategy recommendations, the TAMEC will review and approve the recommendations for implementation.

Performance targets that drive this strategy? (continued)

- Long term goals and initiatives relevant to the sustain steel program

Goals for improving asset management practices

Goals

G9 Information on asset attributes (condition, performance, and costs) is complete, accurate, and readily accessible

G10 Assets are proactively maintained and replaced

- **Maintenance, replacements and sparing planning is integrated**
- **Priority is given to critical assets at greatest risk of failure or noncompliance**
- **Reliability, availability, and other standards are met at least life-cycle cost**

G11 Maintenance is reliability-centered (condition-based)

Strategic initiatives

S-1. Establish processes, procedures, controls, roles & responsibilities to ensure nameplate, condition assessment, outage history, maintenance costs and other asset information is accurate, complete, and readily accessible via the Transmission Asset Register (implementation to be addressed through the IPPI projects) (G9) (Lead: TPO)

S-2. Maintain or replace existing communications, control and operations infrastructure on a timely basis to ensure reliable, efficient, secure, and safe operation of the power system (G10, G11) (Lead: TPO)

- Develop and implement policies, guidelines, and standards that ensure communications, control and operations infrastructure will comply with regulatory standards and requirements

S-3. Prioritize and manage maintenance and replacement backlogs to sustainable levels (target dates set in life-cycle strategies for each sustain program) (G10, G11) (Lead: TPO)

S-4. Develop and implement a process that ensures replacement and maintenance actions result in no more than X% of critical assets at high risk of failure or noncompliance (target percents and target dates set in life-cycle strategies for each sustain program) (G10, G11) (Lead: TPO)

S-5. Develop and implement sparing strategies to assure a supply of critical spare parts is geographically situated to enable timely restoration of service (G10) (Lead: TPO)

S-6. Establish condition-based maintenance standards and implement reliability-centered maintenance as each asset class is added to TAS (G11) (Lead: TPO)

S-7. Develop a near term process and plan for integrating asset strategies across programs where interdependent equipment drives coordinated investment decisions. Plan to include defined scope, timeline, funding, and committed resources. (Lead: TPO, Support: TPW)

Performance targets that drive this strategy? (continued)

- Transmission system performance measures for Reliability and Availability

System performance metrics and targets

Reliability - SAIDI: Zero control chart violations for line categories 1-2, and no more than 1 violation per year for line categories 3-4

Reliability - SAIFI: Zero control chart violations for line categories 1-2, and no more than 1 violation per year for line categories 3-4

Availability: 98 percent per year for line categories 1-2, and XX percent for line categories 3-4

- Safety: The lost-time accident frequency rate is ≤1.5. No fatalities occur to BPA employees or contract employees working on BPA facilities.

Performance Objectives and Targets

- **Transmission Line Reliability**
  - **Performance Objective**: Reduce or avoid unplanned outages on BPA's most important steel transmission lines (category 1 and 2) due to equipment condition or age related failures.
  - **Measures**: Outage frequency (SAIFI) and duration (SAIDI) due to equipment condition or age related failure
  - **End-stage Targets**:

    Maintain SAIDI and SAIFI at or below historic averages:
    - Zero Control Chart Violations for SAIDI and SAIFI for category 1 & 2 lines
    - No more than one control chart violation per year for line categories 3 & 4

- **Transmission Line Availability**
  - **Performance Objective**: Ensure BPA's steel transmission lines meet availability targets.
  - **Measures**: Duration of planned outages for maintenance
  - **End-stage Target**: BPA's most important transmission lines (Category 1 and 2) are available for service at least 98.0% of the time.

Performance Objectives and Targets (continued)

- **Safety**
  - **Performance Objective**: BPA transmission lines are maintained and operated in a way that limits risk to health and safety of employees working on the lines and to the public
  - **Measures**: Frequency of lost-time accidents and near misses
  - **End-Stage Target**: Lost-time accident frequency rate ≤ 1.5 per 100,000 hours worked, No fatalities occur to BPA employees or contract employees working on BPA facilities

- **NERC/WECC Maintenance & Inspection Compliance Criteria**
  - **Performance Objective**: BPA is adequately inspecting, assessing, documenting and maintaining its transmission lines in accordance to WECC Standard FAC-501-WECC-1 (A Regional Reliability Standard to ensure the Transmission Operator or Owner of a WECC transmission path performs maintenance and inspection on identified paths as described by its transmission maintenance plan)
  - **Measures** (this is what NERC/WECC requires that BPA do)
    - Transmission Maintenance & Inspection Plan (TMIP) is developed, documented and reviewed annually
    - Maintenance is performed in accordance with the TMIP
    - Maintenance records are maintained as required by this Standard (documentation exists that the Transmission Lines have been regularly inspected, conditions have been noted and corrected in a timely fashion)
  - **End-Stage Target**: There are no violations to NERC/WECC maintenance and inspection standards

Performance Objectives and Targets (continued)

- **Transmission Asset Data Adequacy and Availability (G9)**
  - **Performance Objective**: As lines are inspected on a scheduled basis, information on active and passive component attributes and condition is complete, accurate and readily accessible in TAS.
  - **Measures**:
    - Extent to which a framework for collecting and retaining program critical component condition data is provided for in TAS or Interim data collection and management system
    - Availability of complete, accurate and readily accessible asset attribute information in TAS
  - **End-Stage Target**:
    - 95% of program critical asset data is being collected and managed within one year of the inception of TAS (or an adequate interim data collection and management system.)
    - 90% asset attribute and condition data for 99% of steel line assets inspected after the inception of TAS (or an adequate interim data collection and management system) is available through that system.

Performance Objectives and Targets (continued)

- **Assets are proactively assessed, maintained and replaced (G10 & G11)**
  - **Performance Objective**: Assets are proactively assessed, maintained and replaced
    - Priority is given to critical assets at greatest risk of failure
    - Reliability, availability, and other standards are met at least life cycle cost
    - Maintenance is reliability-centered and condition-based
    - Maintenance, replacements and sparing planning is integrated
    - Reduce the risk of unplanned outages
  - **Measures**:
    - Percent of critical assets at high risk of failure (G10, G11)
    - Percent of asset classes that have condition-based maintenance standards (G11)
    - Extent to which sparing strategies are in place to assure that a supply of critical spare parts is geographically situated to enable timely restoration of service (G10)
  - **End-Stage Target**:
    - Risk assessments are updated every 6 years
    - The number of circuit miles for active components in the high risk category has decreased by ten percent from the last update period
    - Condition-based standards are in place for 80% of asset classes by the end of FY12
    - Sparing strategies are in place for BPA's most critical assets by the end of FY13

What equipment and facilities are covered?

What performance objectives, measures and targets should be set?

What is the health of the assets, and what risks must be managed?

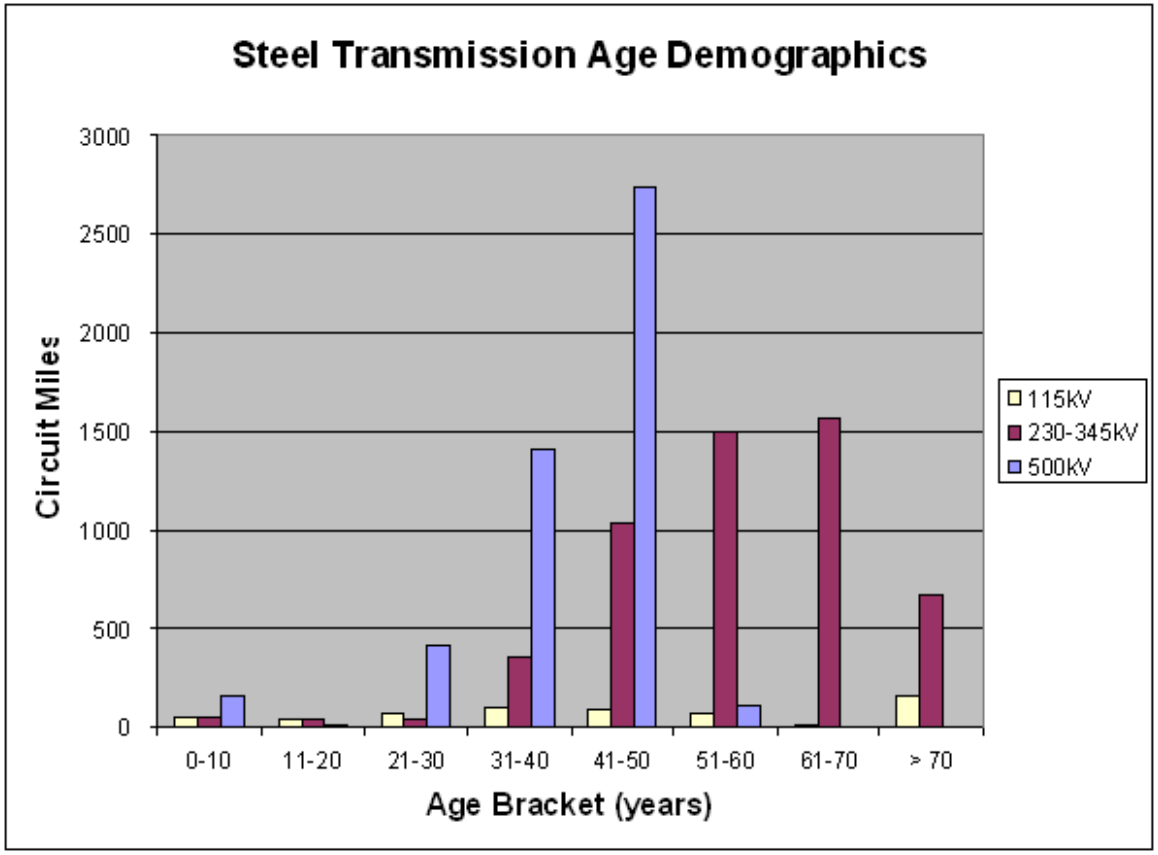
What strategies should BPA undertake?

What will it cost?

Program Accomplishments to date.

Transmission Line Age

- Much of the primary loop and significant portions of the Southern Intertie exceed 40 years of service life
- With the average age of all 10,660 circuit miles being 48 years, the 2007 Aging Asset Report concluded key components were approaching theoretical end-of-life on 60% of BPA's installed asset



Steel Line Health Assessment

- Overhead steel lines make up a vast and complex physical and electrical system, and is difficult to characterize as a population. To build a quantitative evaluation of the asset's overall health, the steel transmission system was separated into 11 major components organized by common, age-related attributes.

- Currently the only overhead asset component for which condition has been consistently assessed and documented over time is wood poles. Data on steel line component health is sparse, making the data documenting efforts presently underway crucial to the success of this sustain program. Three key elements necessary to adequately document BPA's transmission asset and it's condition are:
  - TLDD- Transmission Line Design Data
    - To understand a specific line's design parameters
    - To analyze line physical/structural capacities
    - For line rating
  - TAS – Transmission Asset System (for asset health data)
    - For recording, retaining and managing comprehensive asset health assessment data in order to properly manage, assess and analyze the overhead asset
    - It is likely that an interim solution will have to be adopted in engineering in order to stay on track with having adequate component condition data for making sustain program decision. Whatever interim solution, it will be such that data can be easily transferred to any future TAS database structure
  - Comprehensive metrics for regularly and consistently collecting and retaining asset condition data
    - To identify trends
    - To assist in targeting and timing replacement programs
    - To facilitate effective management over time
    - To assist in refining predictions on component service life as impacted by site conditions

Steel Line Health Assessment (continued)

- Recognizing that major line components will age at different rates, these 11 components as populations that facilitate efficient health and risk assessments have been grouped and identified

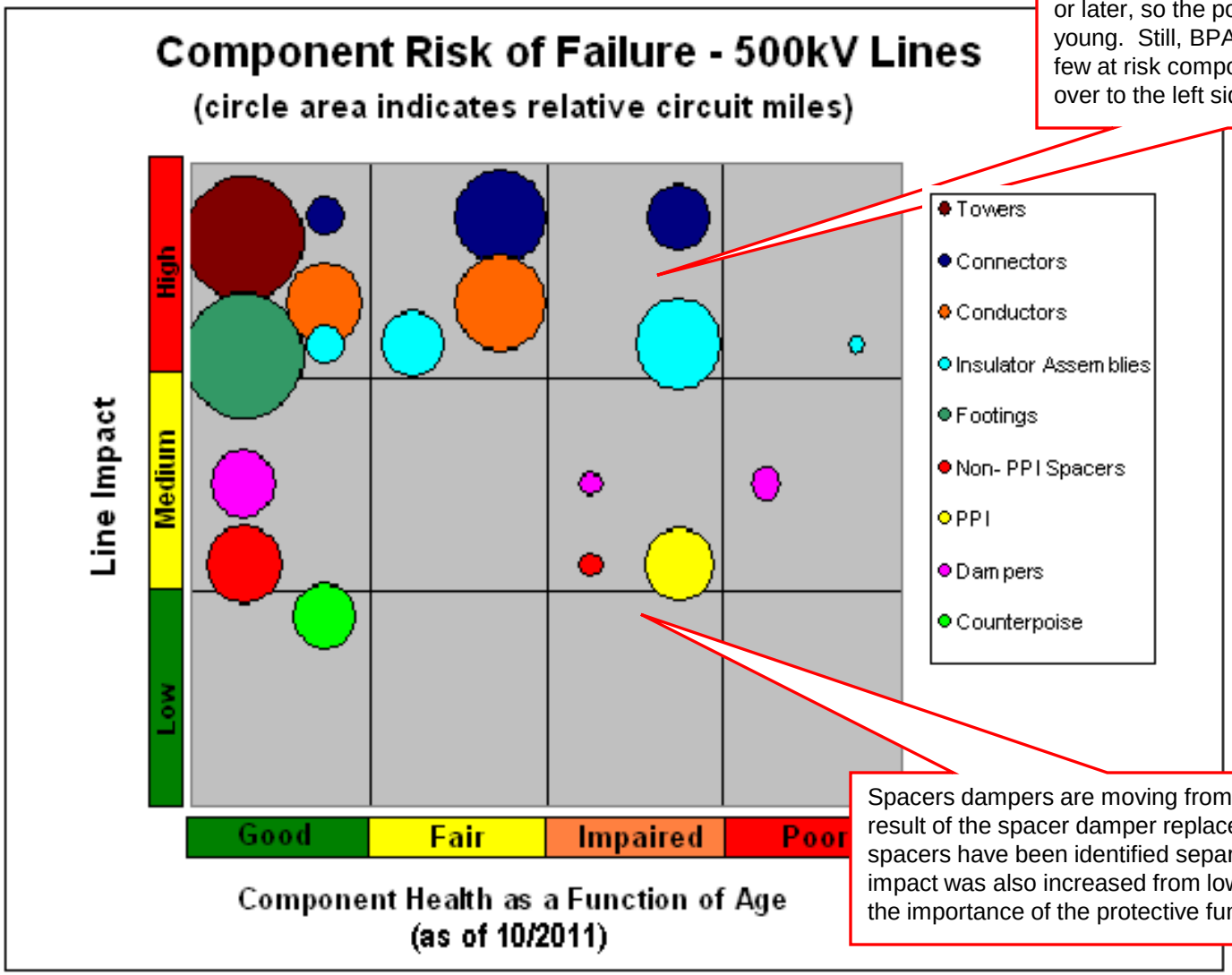
  - Active Components
    - Age faster
    - Low replacement cost
    - Critical or Protective function

  - Passive Components
    - Last longer
    - High Replacement Costs
    - Assessment more difficult

Steel Line Health Assessment (continued)

- For the purposes of this FY12 strategy update, line health is generally based on 2007 “Aging Overhead Transmission Asset: Condition and Risk Assessment” report. The health of specific lines is based on line age, field observed and reported condition, and engineering judgment.
- The chart below is the population based assessment from the Aging Asset Report, with some modifications based on work done between 2008 and 2012 on Spacer dampers and airway warning.

	Major Component	Physical Condition			Obsolescence			Remaining Life			Asset Health
		Good	Fair	Poor	Good	Fair	Poor	>20	10-20	<10	
Passive	Conductors										Good
	Towers										Good
	Tower Footings										Fine
	Guys										Fine
	Counterpoise										Fine
Active	Connectors										Impaired
	Insulators										Impaired
	Dampers										Good
	Spacers										Impaired
	Airway Warning										Impaired



The 500kV lines were built in the 1960s or later, so the population is relatively young. Still, BPA wants to move the few at risk component populations back over to the left side of the chart.

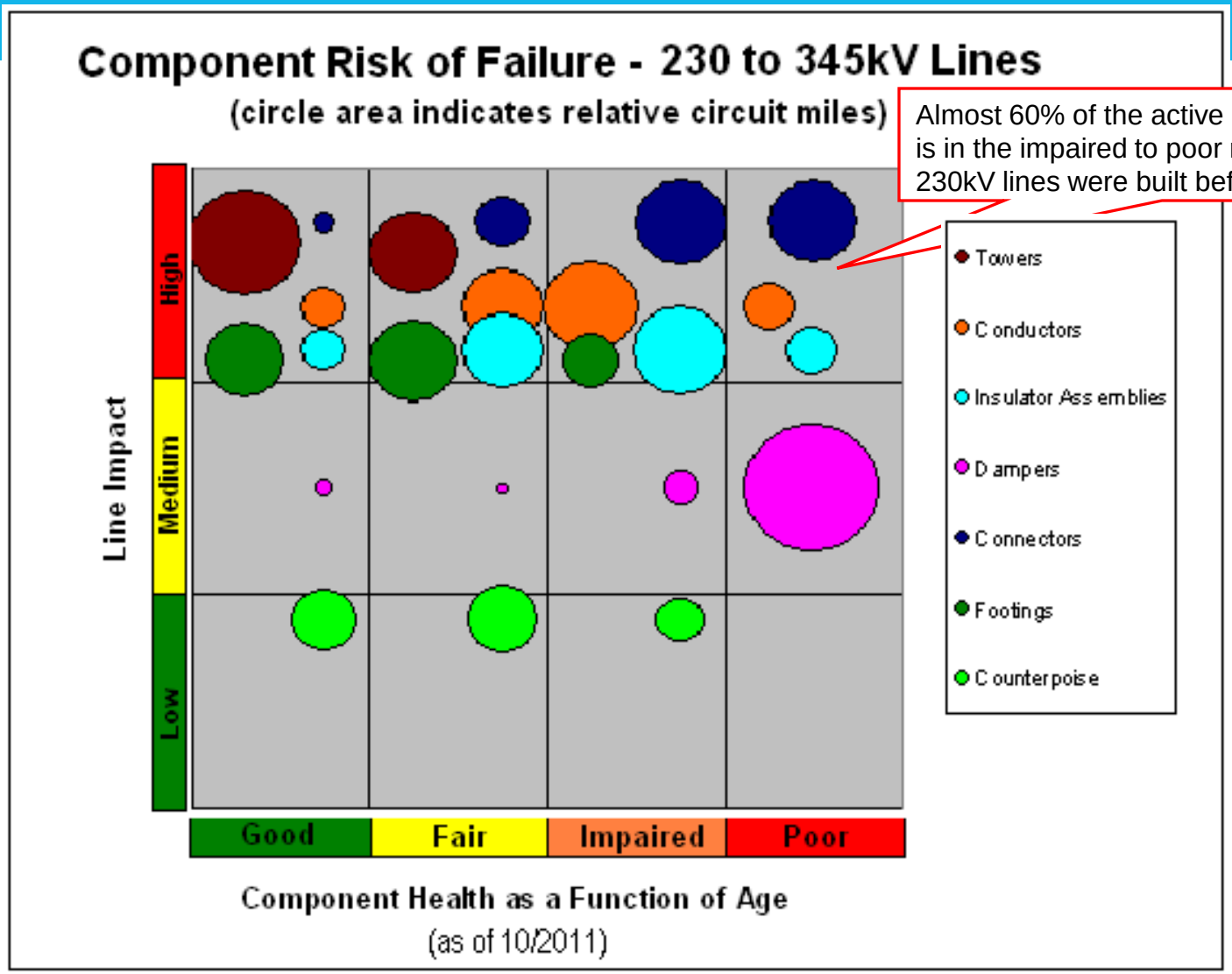
Spacers dampers are moving from Poor to Good as a result of the spacer damper replacement program. PPI spacers have been identified separately. System impact was also increased from low to medium, due to the importance of the protective function they serve.

Component Condition Characterization Parameters for 500kV Lines
(as of 10-2011)

Component	Average Estimated Life Span	Age Range at "GOOD"	Circuit Miles at "GOOD"		Age Range at "FAIR"	Circuit Miles at "FAIR"		Age Range at "IMPAIRED"	Circuit Miles at "IMPAIRED"		Age Range at "POOR"	Circuit Miles at "POOR"	
Towers	100	≤ 60	4842	100%	61-80	0	0%	80-100	0	0%	>100	0	0%
Conductors	70	≤ 40	1995	41%	41-55	2847	59%	56-70	0	0%	>70	0	0%
Insulator Assemblies & Associated	40	≤ 30	584	12%	31-40	1411	29%	41-50	2738	57%	>50	109	2%
Connectors	60	≤ 30	584	12%	31-45	2936	61%	46-60	1322	27%	>60	0	0%
Non-PPI Spacers	40	≤ 20	2094	90%	21-30	0	0%	31-40	235	10%	>40	0	0%
PPI Spacers	N/A	N/A	0	0%	N/A	0	0%	N/A	1700	100%	N/A	0	0%
Dampers	40	≤ 20	1510	73%	21-30	0	0%	31-40	208	10%	>40	352	17%
Footings	80	≤ 50	4733	98%	51-65	109	2%	66-80	0	0%	>80	0	0%
Counterpoise	80	≤ 50	3905	98%	51-65	80	2%	66-80	0	0%	>80	0	0%

Updates for 2011:

- Total mileage dropped for dampers because quantities were recalculated to include only the twin and single bundle conductor.
- Total mileage dropped for counterpoise; engineering estimate are that about 82% of 500kV lines have counterpoise (although this is probably high.)
- PPI Spacer Dampers were listed separately


Component Risk of Failure - 230 to 345kV Lines
(circle area indicates relative circuit miles)
Almost 60% of the active component population is in the impaired to poor range. Most of BPA's 230kV lines were built before 1970.
Towers
Conductors
Insulator Assemblies
Dampers
Connectors
Footings
Counterpoise
Line Impact
High
Medium
Low
Good
Fair
Impaired
Poor
Component Health as a Function of Age
(as of 10/2011)

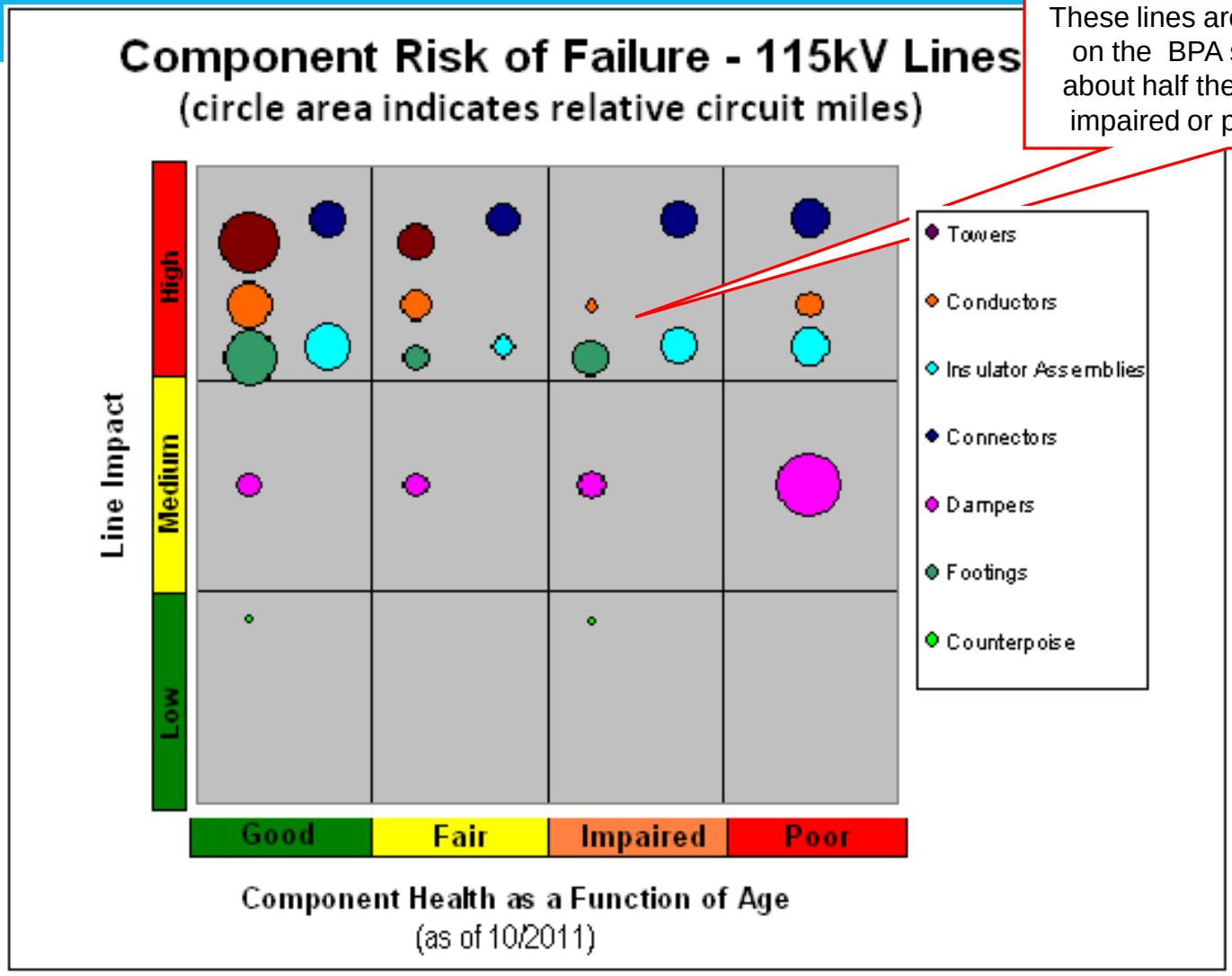
Component Condition Characterization Parameters for 230-345 kV Lines

(as of 10-2011)

Component	Average Estimated Life Span	Age Range at "GOOD"	Circuit Miles at "GOOD"		Age Range at "FAIR"	Circuit Miles at "FAIR"		Age Range at "IMPAIRED"	Circuit Miles at "IMPAIRED"		Age Range at "POOR"	Circuit Miles at "POOR"	
Towers	100	≤ 60	3013	62%	61-80	1850	38%	80-100	0	0%	>100	0	0%
Conductors	70	≤ 40	482	10%	41-55	1537	32%	56-70	2177	45%	>70	667	14%
Insulator Assemblies & Associated	50	≤ 40	482	10%	41-50	1537	32%	51-60	2177	45%	>60	667	14%
Connectors	60	≤ 30	129	3%	31-45	794	16%	46-60	2090	43%	>60	1850	38%
Dampers	40	≤ 20	92	2%	21-30	37	1%	31-40	353	7%	>40	4381	90%
Footings	80	≤ 50	1514	36%	51-65	1895	45%	66-80	825	19%	>80	0	0%
Counterpoise	80	≤ 50	1047	36%	51-65	1309	45%	66-80	553	19%	>80	0	0%

Updates for 2011:

- Total mileage dropped for counterpoise; engineering estimate are that about 60% of 230kV lines have counterpoise.



These lines are some of the oldest on the BPA system, and about about half the population is in an impaired or poor state of health

Component Condition Characterization Parameters for 115 kV Lines

(as of 10-2011)

Component	Average Estimated Life Span	Age Range at "GOOD"	Circuit Miles at "GOOD"		Age Range at "FAIR"	Circuit Miles at "FAIR"		Age Range at "IMPAIRED"	Circuit Miles at "IMPAIRED"		Age Range at "POOR"	Circuit Miles at "POOR"	
Towers	100	≤ 60	422	72%	61-80	162	28%	80-100	0	0%	>100	0	0%
Conductors	70	≤ 40	261	45%	41-55	139	24%	56-70	33	6%	>70	151	26%
Insulator Assemblies & Associated	50	≤ 40	261	45%	41-50	85	15%	51-60	76	13%	>60	162	28%
Connectors	60	≤ 30	156	27%	31-45	130	22%	46-60	136	23%	>60	162	28%
Dampers	40	≤ 20	84	14%	21-30	72	12%	31-40	105	18%	>40	323	55%
Footings	80	≤ 50	346	59%	51-65	87	15%	66-80	151	26%	>80	0	0%
Counterpoise	80	≤ 50	5	56%	51-65	1	11%	66-80	3	33%	>80	0	0%

Updates for 2011:

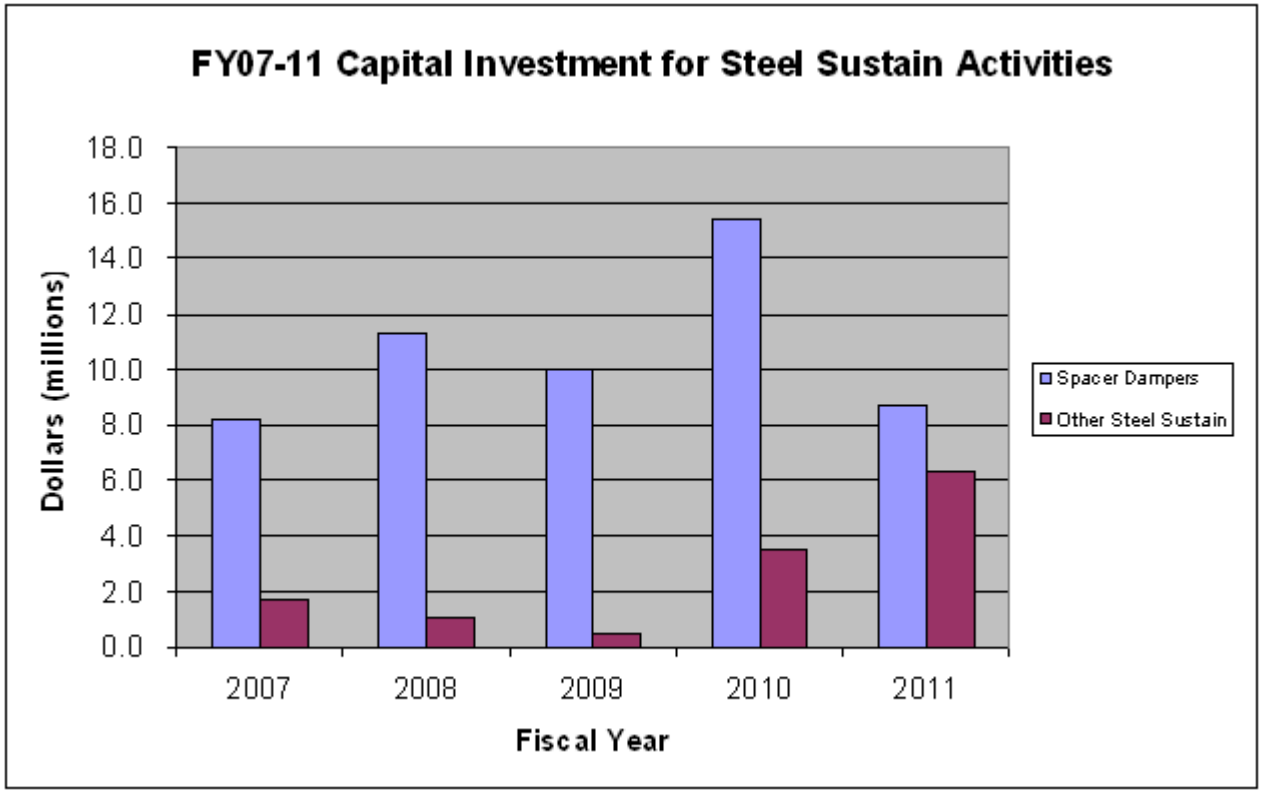
- Total mileage dropped for counterpoise; engineering estimate are that only about 2% of 115kV lines have counterpoise.

Performance History

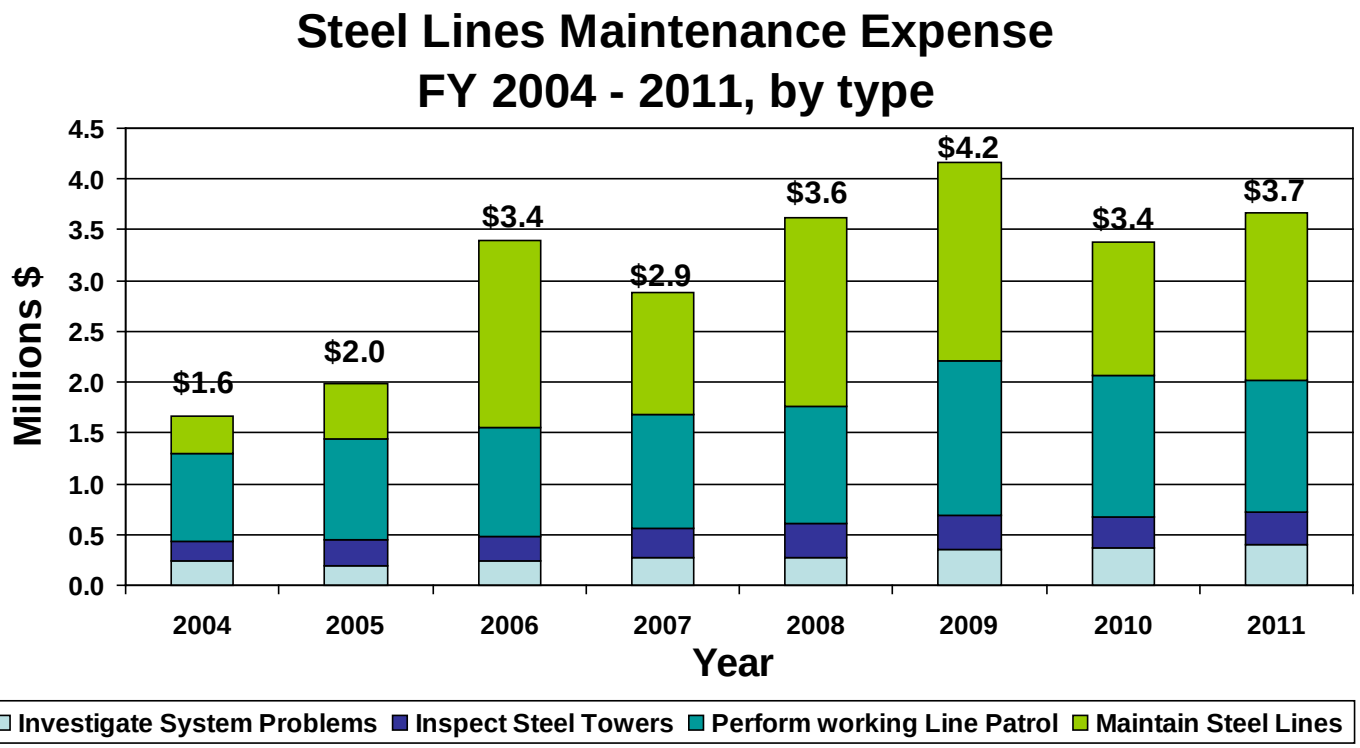
- In the period from 2005 through September 2011, BPA experienced 41 outages in excess of 240 minutes that were likely due to material failure.
- As a proxy for deteriorating condition, the increasingly advanced age of components is assumed to increase their likelihood of failure during severe weather.
- BPA's steel lines are not crumbling to the ground, although the transmission system is experiencing material failures that clearly indicate that active components have a finite lifespan and are approaching that limit.
  - Recent ground wire failures on Fairview-Rogue
  - Recent insulator failures on Olympia-Grand Coulee
  - TLM observations on North Bonneville-Troutdale and Bonneville-Hood River that tower attachment points for suspension insulators have worn thin.
  - Engineering's concerns about fittings on copper and 2.5" expanded experiencing thermal failure

Cost History

- **Capital cost for replacement projects**
  - Spacer Damper Replacement for FY07-FY11: $53.6 million
  - Sustain Steel program related projects for FY07-Fy11: $13 million.



Historic Inspection and Maintenance Expense



- As steel lines continue to age, expense to maintain will increase.
- A major component of this cost is labor hours, to inspect and maintain these lines. Costs exclude right-of-way maintenance, access roads and vegetation management.
- The strategy for these lines, as well as wood, includes improvements in asset information – component condition, line performance and cost.

What risks must be managed?

- **Transmission Reliability**

  Performance Objective: Reduce or avoid unplanned outages on BPA's most important steel transmission lines (category 1 and 2) due to equipment condition or age related failures

  - **Risk:** Components which are approaching or have reached their end-of-life begin to fail and continue to fail in increasing numbers, resulting in an increased likelihood of unplanned outages.

  - **Likelihood:** Very likely. Line components that experience mechanical load cycles have a finite lifespan; eventual failure is inevitable, even more so for those components considered to be a high risk of failure.

  - **Consequence:** Significant
    - Reliability of the operating line will decrease
    - SAIFI and SAIDI end-stage targets will increasingly not be met
    - Failing components could result in extended line outages
    - Maintenance costs to repair or replace failing components in a piece meal fashion will be less cost effective than a proactive whole line component replacement approach
    - Station equipment will experience increased duty with increasing automatic outages
    - Staff will be diverted from implementing planned program work

What risks must be managed? (continued)

- **Transmission Availability**

  Performance Objective: Ensure BPA's steel transmission lines meet availability targets.

  - **Risk:** The anticipated increase of replacement work will lead to an increasing frequency of planned outages resulting in decreased transmission line availability.

  - **Likelihood:** Likely. Line components that experience mechanical load cycles have a finite life expectancy; eventual failure is inevitable and without a systematic approach to preemptive replacement, the failure rate will likely be unmanageable from a maintenance perspective.

  - **Consequence:** Significant
    - Maintenance backlog will increase to an unsustainable level.
    - Maintenance costs to repair or replace failing components in a piece meal fashion will be less cost effective than a proactive whole line component replacement approach.
    - Availability of the operating line will decrease overtime, until enough hardware has been replaced to move the line out of a high maintenance category.

What risks must be managed? (continued)

- **Safety**

  Performance Objective: BPA transmission lines are maintained and operated in a way that limits risk to health and safety of maintenance employees and the public.

  - **Risk:** Age-related deterioration of line components results in component failure during maintenance activities, storm events, etc, leading to injury or death.
  - **Likelihood:** Low. Depending on the failure mechanism, it may be difficult for field personnel to readily identify materials, like insulators, that have severely deteriorated strength capacity.
  - **Consequence:** Significant – Potential injury or loss of human life

- **NERC/WECC Management and Compliance Criteria**

  Performance Objective: BPA is inspecting, assessing, documenting and maintaining transmission lines in accordance to WECC Standard PRC-STD-005-1

  - **Risk:** Being found not in compliance with NERC/WECC standard PRC-STD-005-1 through self report or during NERC/WECC audit leads to mandatory emergency remediation with possible financial penalties that results in increased expense costs and loss of reputation.
  - **Likelihood:** Low
    - BPA currently has a TMIP in place,
    - Maintenance is performed in accordance with the TMIP
    - Maintenance records are maintained as required by this Standard
  - **Consequence:** Moderate – There are possible fines for non-compliance and BPA could be ordered to take expensive corrective actions within a short time frame.

What risks must be managed? (continued)

- **Transmission Asset Data Adequacy and Availability (G9)**

  Performance Objective: As lines are inspected on a scheduled basis, information on active and passive component attributes and condition is complete, accurate and readily accessible in TAS.

  - **Risk**: BPA does not have the information available to help identify condition trends or to predict service life, making it difficult to effectively target, pace and manage replacement and maintenance programs.
  - **Likelihood:** High
    - It is still not clear what resources are available to manage the systematic testing and assessment of a statistically significant sampling of aging component populations, which is a critical part of this strategy's success.
    - TAS development is not meeting it's previous schedule however, discussions on ways to continue making progress on the data adequacy and availability objective are on-going.
  - **Consequence:** Significant
    - Replacement and maintenance decisions based on inadequate asset condition information can potentially lead to significant over or under spending within the program and inefficient program targeting and pacing.

What risks must be managed? (continued)

- **Assets are proactively assessed, maintained and replaced (G10 & 11)**

  Performance Objective: Processes are developed to ensure that assets are proactively assessed, maintained and replaced

  - **Risk:** Maintenance cannot overcome the anticipated backlog of work, material for restoring service is not readily available or BPA is not gathering and tracking adequate data to make well informed maintenance decisions.
  - **Likelihood:** Moderate
  - **Consequence:** Significant – Decreased reliability due to increasing frequency of unplanned outages. Reactionary replacement efforts to keep up with failures results in increased overall program costs.

- Notes: The likelihood increased from Low to Moderate because efforts to formally establish maintenance and inspection standards that specifically address sustain program issues have not been assigned a high enough priority to ensure that this can be accomplished in a timely manner.

What equipment and facilities are covered?

What performance objectives, measures and targets should be set?

What is the health of the assets, and what risks must be managed?

What strategies should BPA undertake?

What will it cost?

Program Accomplishments to date.

Strategy Considerations

- **Load growth and long term reliability**
  - In targeting lines for refurbishment, a feedback loop with expansion planning is being established to ensure a thoughtful and coordinated line specific strategy that is long-term, proactive, and regional in scope

- **Determining Asset Condition**
  - In order to accurately assess and appropriately target and pace steel line component replacement efforts, BPA must have in place a systematic approach to track and document the condition of its assets over time
  - The future of asset maintenance tracking and documentation is unknown
    - The goal is systematic accounting of what's out there, what's wearing and breaking and what's being fixed
    - Ease of reporting recurring issues on the system that will feed into program development
    - A system for collecting and managing asset condition data has not yet been determined
  - A resource strategy must be developed for managing and orchestrating on-going component evaluation: sampling, testing, assessment and reporting

Strategy Considerations (continued)

- **Component Population Condition Assessment**
  - While 500kV lines are most critical they are younger and tend to be in better condition
  - Whereas the 115kV and some 230kV lines are less critical, they are older and appear to be at greater risk of failure. Effort needs to be put toward restoring the health of these lower voltage lines
  - Proper management of the overhead asset is critically dependent on the reliability and availability of condition assessment data, related analysis, and timing of replacement efforts

- **QA/QC Requirements**
  - There is now an increased emphasis on QA/QC in order to avoid the kinds of material quality issues we've experienced in the last few years
  - It's been broadly acknowledged that BPA cannot have successful partnerships with material suppliers without a robust internal QA program, and that's what has been developed in Transmission Line Engineering

- **Maintenance strategies for steel lines need to be refined to address issues of an aging population**
  - Robust maintenance standards and procedures for aging steel lines must be in place, integrated with TAS and reviewed annually
  - Forecast costs necessary to perform adequate maintenance on aging steel lines.
  - Share information with other utilities on approaches for maintaining an aging system.

Strategy Considerations (continued)

- **Material Constraints**
  - Major materials to support BPA expansions and sustain programs are currently procured through long-term master contracts, which are all subject to price adjustment review and supplier lead time updates
  - Materials without long term master contracts are purchased as needed on a first come first served basis
  - Due to current US and global infrastructures demand, production capacity, currency fluctuations, laws and regulations, materials suppliers are less capable/flexible in meeting BPA requirements and last minutes demands
  - In order to meet program schedules, critical elements must be communicated to Supply Chain – Sourcing Services in advance:
    - Current year materials forecasts and construction plan; internal crews vs. construction contractors
    - 3-years rolling materials forecast estimates
    - On-going communication between project implementers and Commodity Managers on project scope changes/updates and material availability updates.
    - Provide clear project scope, funding method, and required timeline to SC Sourcing Services during project planning phase
  - Continue to explore utilizing commercial off-the-shelf items by adopting industry standards, where it makes sense; value added benefits as follow:
    - Total cost optimization to projects and rate payers
    - Improve material availability
    - Fast track on new supplier qualification process
    - Free up internal resource constraints

Strategy Considerations (continued)

- **Staffing Constraints**
  - The level of construction resources necessary to adequately accomplish transmission system refurbishment significantly exceeds those of routine maintenance and will require the use of internal and external resources.

- **Outage Constraints**
  - Refurbish work involving conductor hardware is most efficiently performed while the line is not energized.
  - Extended outages are difficult, if not impossible, to get on some lines; BPA needs to continue to develop Live Line maintenance resources

- **Evolving Regulatory Standards**
  - NESC – replacement components must meet current standards for quality and electrical functionality
  - Business Continuity: the agency's business continuity objectives must be met

Steel Sustain Program Strategies

- **Asset Vision:** BPA has restored the health of all overhead transmission system components to a state of long-term functionality and reliability and has instituted a proactive, economical, and dynamic strategy for tracking, assessing and mitigating its aging overhead asset over time. In doing this, BPA continues to fulfill its commitment to the region to provide an adequate, efficient, economical and reliable power supply.

- **Process Goals**
  - A Proactive plan to replace vital overhead system components nearing end of life
  - Standard metrics for collecting and retaining asset condition data, with enough granularity to 1) identify condition trends 2) target and pace replacement efforts 3) manage components over time and 4) better predict remaining service life
  - A standardized process for sampling and testing retired components, analyzing results and drawing conclusions that will assist us in pacing and targeting the replacement strategies
  - Long term strategy for evaluating and mitigating a continuously aging asset
  - Data quality and reporting is adequate in TAS (transmission Asset System) or other interim data collection and management system and TLDD (Transmission Line Design Data) to serve in effectively tracking and evaluating the overhead asset
  - Standardized components and technology innovations appropriately incorporated into replacement efforts
  - Documented lessons learned available so that every cost-effective effort is made to ensure that new projects are assembled with the best chance for a long and reliable service life

Steel Sustain Program Strategies (continued)

- **Spacer Damper FY08-12 Multi-year Program (currently underway) FAS 71**
  - Spacer damper components on a majority of the population are reaching their end of life. This program systematically replaces these aging components throughout BPA's system, with a sunset of FY 2012.
    - Component replacement on entire lines in one outage
    - Combination of contract and BPA labor
    - Contract package covers all projects within a construction season
    - Relatively short outages and fast paced
  - This program has encountered some material quality issues with PPI spacer dampers not meeting the specification. As a result, a renewed look at the importance of QA/QC here at BPA has been spurred. QA/QC is a vital part of having a successful and effective partnership with material suppliers and helps to assure that expected material quality and longevity is met.
    - There are approximately 1700 circuit miles of installed PPI spacer dampers that BPA knows do not meet specifications
    - There are a couple dozen confirmed failures to date and SME's in Line Design Engineering have determined through extensive sampling that 21% of the PPI population are on a path to failure
    - A three year program is underway now (FY12-14) to replace all PPI spacers on BPA's system, at a cost of $34 million. Please refer to the Sustain Steel Defective Spacer Re-replacement Business Case (TFY120107) for further details

Steel Sustain Program Strategies (continued)

- **Insulator Assemblies and Associated Hardware (started FY11) <u>Capital</u>** Replace insulator assemblies and associated hardware. Shunt deadend and jumper connections.

  Background: The condition of the insulator assemblies and associated hardware is not always obvious and can be difficult to ascertain by field observation alone. An on-going strategy for testing retired components will give us the data necessary to appropriately target and pace the program.

  - Phase One
    - Replace insulator assemblies and associated hardware on discrete line sections.
    - Shunt compression fittings at deadends
    - Based on age of asset, field observation of condition, weather exposure, frequency of material caused outages, line criticality and outage availability, a group of line sections is targeted for the first three years of the program, this list will evolve as new information becomes available.
    - Determine construction resources available and skill enhancement necessary to address hard to take out lines, which are often the most critical.
    - Replacement assemblies will have been reviewed and revised as necessary to meet current policy to standardize hardware components when ever possible.
    - As insulator assemblies and associated hardware are replaced, a statistically significant sampling of the retired population must be evaluated to determine actual component condition, help refine service life predictions and identify predictors of urgency
    - These evaluations will give us the data necessary to determine the pace at which this effort should move forward over the long term.
    - TAS Implementation was scheduled to begin early to mid FY 2011; effective implementation is critical to the sustain programs. If TAS implementation is delayed, an interim data collection and management solution must employed in Transmission Line Engineering in order to stay on track with data adequacy and availability objectives

Steel Sustain Program Strategies (continued)

- **Insulator Assemblies and Associated Hardware** (continued)
  - Phase Two (on-going:)
    - Reevaluate the strategy for insulator assembly and associated hardware replacement for the next multi-year program period based on retired component analysis and other phase one program lessons learned.
    - Structure the next three to five year program period according to urgency and critical indicators uncovered in phase one.
    - Continue to refine condition data collection efforts to best meet asset management needs

- **Airway Marking (currently underway) Expense**
  - Program started in 2004
  - Theoretical lifespan is 10 years for the fixture and 2-4 years for the flashtube.
  - Region expense budgets may allow between two and six towers per year (between $5K and $60K)
  - Program cost to date is about $3 million
  - Replacements prioritized based on criticality, condition and maintenance frequency and complexity
  - Standardizing around low maintenance, self-contained fixtures
  - Replace marker balls in conjunction with spacer replacement when possible
  - Program tracking is currently done by the PM on a locally maintained list, TAS will be taking over this function eventually.

- **Steel Tower Components (strategy development currently underway) Expense/Capital**
  - A steel transmission tower has a theoretical lifespan of 100 years, and footings up to 80 years.
  - Underground components may have corrosion issues that shorten this lifespan
  - Points of interface between the tower and the insulator string may experience accelerated wear.
  - Develop a systematic way to assess document and track over time the condition of these passive components and their more vulnerable subparts. The expectation is that TAS will provide the means for collecting, storing and tracking this information.

Steel Sustain Program Strategies (continued)

- **Other Components of the Steel Sustain Program:**
  - **Developing and Implementing assessment strategies for all transmission line components**.
    - Working with utility partners to share information, the entire industry is facing this issue
    - Developing and validating testing and assessment methods
    - Determining what parameters should be documented by TLM in TAS
    - Determining condition thresholds that will guide program schedule.
    - Component testing, assessment and tracking
  - **Other replacement and maintenance activities**
    - Tower steel repair
    - Footing repair and protection
    - Guying repair or replacement
    - Conductor splice reinforcement – shunting
    - Premature spacer replacement due to material quality issues

Alternative Strategies Considered

- **Alternative Strategies for steel lines**:
  - Status Quo – Continue with the philosophy that steel lines don't require much more than occasional insulator bell or string replacement and address other material failures as they come up.
    - Not sustainable, higher cost for piecemeal approach
    - Does not address growing backlog of lines well beyond expected service life
    - Increasing risk of unplanned outages due to component failures
    - It is difficult to assess the condition of insulators by observation alone
  - Aggressive Age-Based Replacement of Active Components - Aggressive replacement of active components based on predicted life expectancy. 500kV insulators would be replaced at 40 years, for example.
    - Challenge to implement and strains resources
    - Outages necessary to complete the work would be very difficult
    - Improves long-term reliability but would adversely impact short-term availability
    - Likely that many line components would be replaced before end of service life
  - Proactive Condition Based Replacement of Active Components – **APPROVED** - Beginning with an age-based approach, discrete line segments will be targeted for replacement. A sampling of retired components will be evaluated and results will be documented along with factors like age, manufacturer, geographic location, weather exposure etc. in order to refine life expectancy predictions, better target high risk lines and appropriately pace the program.
    - Starts with what BPA does know about the lines
    - Refines the approach base on actual component condition

What equipment and facilities are covered?

What performance objectives, measures and targets should be set?

What is the health of the assets, and what risks must be managed?

What strategies should BPA set?

What will it cost?

Program Accomplishments to date.

Forecast Planning Levels

- **IPR Summary and forecast logic**
  - The average cost per mile for insulator replacement on 500kV lines in FY11 was about $73,000 per mile materials and labor. Based on an anticipated increase in contract labor due to constrained BPA labor, the estimate has been increased to $82K per mile for planning purposes.
  - The target for 2012 is 80 miles and for 2013 is about 100 miles. For the next program period (FY14-17) we've planned for an annual budget of about $12.4 million, which matches the IPR projection.
  - The 2018 budget level of $11.5 million is held through 2021
  - Roads and associated environmental work will be programmed by the Access Road PM
  - Over the course of the program, analysis on a sampling of retired components will be on-going and will inform how the program will evolve over time.
  - BPA's steel transmission system consists of about 10,660 circuit miles of line. At a refurbish rate of between 100 and 150 miles per year, it will take about 75 years to refurbish the system. Although between 40 and 60 percent of BPA's system is approaching theoretical end of life for, program evolution will rely on asset assessment and retired component analysis to reinforce or refine that assumption.
  - What remains to be determined is the longevity of the steel towers and footings themselves. At this time, towers are predicted to have a lifespan of 100 years and footings are predicted to have a lifespan of 80 years. The wholesale replacement of these passive assets will require a much greater capital investment than the active components.
  - Expense dollars should be earmarked for sustain activities and those dollars should be controlled at the program level
  - Decisions will have to be made within the next 20 years about next steps for maintaining the aging transmission system as passive components begin to reach the end of their service life. This will warrant close examination of BPA's long term capacity and network needs for specific corridors as BPA is faced with decisions on replacing passive components, like towers, footing and conductor.

Capital Forecast Planning Levels

Note: This implementation plan is a replacement program with the optimal funding, staffing resources, and outage availability to best mitigate risks identified in the strategy. These numbers may not be aligned with the currently constrained IPR budget. Each sustain program is under review to determine a revised implementation plan that will align with capital budget availability, priorities, and resource constraints. This review will be complete by March 2012.

	Actual FY2011	Estimate FY2012	Estimate FY2013	Estimate FY2014	Estimate FY2015	Estimate FY2016	Estimate FY2017	Estimate FY2018	Estimate FY2019	Estimate FY2020	Estimate FY2021	FY12-21 Total Direct Cost (Millions)
STEEL SUSTAIN												
All Non-Spacer Sustain Steel	*$8.0*	$11.9	$13.2	$12.4	$12.6	$12.9	$13.1	$11.5	$11.5	$11.5	$11.5	$122.1
SPACER DAMPER REPLACEMENT												
FY08-12 Spacer Program	*$10.0*	$5.8	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$5.8
Defective PPI Replacement	*$0.0*	$15.0	$15.2	$4.1	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$34.4
Total Sustain Program Planning Levels	*$18.0*	$32.7	$28.4	$16.5	$12.6	$12.9	$13.1	$11.5	$11.5	$11.5	$11.5	$162.3

Expense Forecast Planning Levels

- This list is intended to start to identify and organize steel sustain program related expense activities and to start zeroing in on dollar magnitude for future planning purposes
- While TLM or contractors are working on capital projects, opportunities for bundling expense activities should be thoughtfully used, in order to maximize the efficiency of each construction crew mobilization and line outage.
- Some replacement activities may start out at the program level then move to the district once a procedure and budget is established.

Activity Category	Activity	Description	Cost per Year	Already Budget Line Item?
Investigation & Discovery	Tower/Footing corrosion study	There needs to be an inspection standard for TLM field reporting, a TAS reporting area, as well as a commitment for follow up by engineering, starting wiht towers with known corrosion issues then, over time, decide if a broader effort is warranted.	$200,000	partially
	Insulator field testing	TLM would do this in conjunction with their tower climbing inspections (10% per year). This is a pass/fail reading that would give us solid data on component health. This would add some small increment of time to tower inspections.	$20,000	no
	LiDAR survey	This will become less likely to occur over time due to the increase in LiDAR survey for other reasons (LiDAR data will be available for most lines.)	$0	yes
Repair	Repair corroded stubs	This would involve grinding out corrosion and splicing in new steel. Maybe some galv-coat and welding, would be necessary. 20 towers per year would be a place to start, ~ $5000 per tower (4 footing stubs each) With a quick ramp up to 60 to 100 per year)	$100,000	no
	Replace Anodes	About $1800 per tower unless it's coupled with stub repair then it's about $1000 per tower (for four anodes) (~30 towers per year (20 bundled with stub repair.) Ramping up to 100 per year	$38,000	no
Expense Component Replacement	Replace signs	The typical estimate is for $1000 per mile, although this has not been reconciled with actuals. There is expense money already earmarked for signs	$500,000	yes
	Replace vibration dampers on single conductor and GW	Vibration dampers serve a protective function to the conductor and hardware. Replacment of fialure units must not be delayed in the district's maintenance plans.	$100,000	no
	Replace Airway lighting	Managed under transmission line design.	$100,000	yes
	Replace Marker Balls	Still scoping	$50,000	no
Tower Moves	Towers in slide areas.	Many of these project witl have a capital and expense component. For a tower move, $50,000 per tower for the expense portion is a good first estimate. Three towers a year is a good starting point.	$150,000	yes
	Tower moves due to other types of on-going location related damage	This item is included in the tower move estimate above		
		Total Expense for Sustain Steel Program	**$558,000**	
		Not Yet Budgeted	**$308,000**	

Planned Expenditures in FY12 for the FY08-12 Spacer Damper Replacement Program

Operating Line	Operating Voltage	Circuit Miles	Typical Estimate Cost Per Mile $ Direct	Total Direct Cost
Big Eddy 500/230 kV Tie No 2	500	0.4	$19,548	$19,548
Big Eddy-Celilo No 1	500	0.7	$19,548	$19,548
Big Eddy-Celilo No 2	500	0.6	$19,548	$19,548
Big Eddy-Celilo No 3	230	1.1	$19,548	$21,307
Big Eddy-Celilo No 4	230	1.0	$19,548	$19,548
Captain Jack-Olinda No. 1	500	6.6	$19,548	$129,017
Chief Joseph Powerhouse No 5	500	0.8	$19,548	$19,548
Covington-White River No 1	230	9.0	$19,548	$174,955
Echo Lake-Maple Valley No 1&2	500	31.5	$19,548	$615,762
Grand Coulee SWYD 230/500 kv Tie No 1	500	1.3	$19,548	$25,412
Hot Springs Sub 500/230 Tie No 1	230	0.1	$19,548	$19,548
Keeler-Allston No 1	500	42.3	$19,548	$826,880
Little Goose Powerhouse No 1	500	1.7	$19,548	$33,232
Lower Granite-Hatwai No 1	500	6.0	$19,548	$117,288
Lower Granite Powerhouse No 1	500	0.8	$19,548	$19,548
Marion-Lane No. 1	500	69.0	$19,548	$1,348,812
McNary-Ross No. 1	345	1.3	$19,548	$25,412
Raver Tap to Schultz Echo Lake	500	3.0	$19,548	$58,644
Santiam 230/500 kV Tie No 1	230	0.3	$19,548	$19,548
Schultz-Raver No 3	500	0.1	$19,548	$19,548
Sickler-Douglas SWYD No 1	230	0.6	$19,548	$19,548
Trojan-Allston No 1	230	8.8	$19,548	$172,022
Trojan-Allston No 2	230	8.7	$19,548	$170,459
Vantage-Hanford No 1	500	23.5	$19,548	$459,378
Wautoma-Ostrander No. 1	500	6.0	$19,548	$117,288
Approximate Total for FY12		225.1		$4,374,060

PPI Replacements Scheduled for FY12

WO Description	Operating Voltage	Circuit Miles in FY12	Estimated Direct Cost
ASHE-MARION NO. 2	500	110.5	$2,210,000
ASHE-SLATT NO. 1	500	26	$650,000
GARRISON-TAFT NO. 2	500	159	$3,180,000
GRAND COULEE-BELL NO. 6	500	82.8	$1,656,000
GRAND COULEE-SCHULTZ NO. 1	500	77	$1,540,000
GRAND COULEE-SCHULTZ NO. 2	500	77	$1,540,000
NAPAVINE-ALLSTON NO. 1	500	1	$30,000
SCHULTZ-WATOMA NO.1	500	61.5	$1,230,000
BUCKLEY-MARION NO.1	500	99	$1,980,000
Approximate PPI Total for FY12		**693.8**	**$14,016,000**

Lines with Known PPI Spacer Dampers for Replacement in FY13-14

Operating Line	Operating Voltage	Circuit Miles	Typical Estimate Cost Per Mile $ Direct	Total Direct Cost
Ashe-Hanford No 1	500	17.3	$19,548	$338,180
Ashe-Slatt No 1	500	72.3	$19,548	$1,413,320
Broadview-Garrison No 1	500	92	$19,548	$1,798,416
Broadview-Garrison No 2	500	92	$19,548	$1,798,416
Buckley-Marion No 1	500	99.3	$19,548	$1,941,116
Dworshak-Taft No 1	500	1.4	$19,548	$27,367
Grand Coulee-Chief Jo No 3	500	31	$19,548	$605,988
Grand Coulee-Hanford No 1	500	96	$19,548	$1,876,608
Hatwai-Dworshak No 1	500	29	$19,548	$566,892
Little Goose-Lower Granite No 1	500	32.8	$19,548	$641,174
Little Goose-Lower Granite No 2	500	32.8	$19,548	$641,174
Lower Granite-Hatwai No 1	500	8	$19,548	$156,384
Lower Monumental - Ashe No 1	500	18	$19,548	$351,864
Lower Monumental - Little Goose No 2	500	24.3	$19,548	$475,016
Pearl-Keeler No 1	500	13.5	$19,548	$263,898
Raver Tap to Schultz-Echo Lake No 1	500	3	$19,548	$58,644
Raver-Echo Lake	500	0.3	$19,548	$19,548
Schultz-Echo Lake No 1	500	74.3	$19,548	$1,452,416
Schultz-Echo Lake No 1	500	9.1	$19,548	$177,887
Schultz-Raver No 1	500	77.2	$19,548	$1,509,106
Slatt-Buckley No 1	500	52.3	$19,548	$1,022,360
Sno King Tap to Echo Lake-Monroe No 1	500	12.8	$19,549	$250,227
Tacoma-Raver No 1	500	24.2	$19,548	$473,062
Tacoma-Raver No 2	500	9	$19,548	$175,932
Taft-Bell #1	500	96	$19,548	$1,876,608
Approximate Known Total for FY13-14		1017.9		$19,911,606

Next Steps

- Communicate and share strategy
  - Share within Transmission Executives to get feedback
- Implement the concept of a continuous Business Case and using incremental increases to that Business Case to fund subsequent program periods
  - This approach would have the same rigor as a new business case, but would allow seamless program continuity by utilizing the same PAR perpetually.
- Participate in the Development of the overall Asset Management Plan
  - Identifies specific projects and initiatives
  - Assigns accountability
  - Delivery date
- Continue to develop the expense component of the sustain program, specifically funding and prioritization of engineering driven expense projects.
- Other Steps
  - Determine funding options for on-going component assessment
  - Determine personnel resources for on-going component assessment
  - Participate in TAS (or other adequate interim data collection and management system) architecture development

What equipment and facilities are covered?

What performance objectives, measures and targets should be set?

What is the health of the assets, and what risks must be managed?

What strategies should BPA set?

What will it cost?

Program Accomplishments to date.

One Year Execution Summary

- **Sustain Steel Program Year One Summary**
  - Line segment selection for refurbishment is currently driven by TLM observation, line criticality, theoretically based expectations about component aging. As we collect and manage more condition data, decision making criteria will shift to actual component condition and critical indicators of likely component deterioration. Discrete line segments were targeted for insulator assembly replacement on Raver-Paul No.1, Taft-Hot Springs No.1, Olympia-Grand Coulee No.1 and Grand Coulee-Bell No. 3 (double circuit).
  - Discoveries of severe conductor damage on Grand Coulee-Bell No. 3 resulted in re-scoping the project to a full line reconductor to begin fall of 2012.
  - A sampling of retired components was sent to the ME lab for analysis. The results are documented in SharePoint and will eventually serve to refine life expectancy predictions, better target high risk lines and appropriately pace the program.
  - The spacer damper replacement program continued successfully for its fourth year.
  - The discovery of faulty spacer damper materials and subsequent analysis spurred an aggressive effort to re-replace all PPI spacer dampers on the system (~1700 miles). A three year program was developed and will begin implementation in FY12.
  - A corrosion mitigation strategy is under development to begin implementation in FY12.
  - High priority projects to relocate towers in active slide or erosion areas are in the design phase to begin execution in FY12.
  - The first projects to mitigate for unplanned outages due to bird dung contamination were implemented.
  - Engineering driven expense projects that fall under the sustain steel program are being identified and estimated in order to budget for and manage this aspect of the sustain effort.
  - (See quantified program accomplishments on slides 57 and 58)

FY10 Program Accomplishments

FY10 Program	Work Planned	Work Accomplished	Explanation for Variance
• Spacer Damper FY08-12	900 miles	914 miles	Within Tolerance

Sustain Steel Plan vs. Actuals, FY 10 ($000s)		
	FY 10 Plan	FY 10 Actuals
Spacer Damper FY08-12	$15,000	$15,400
Total Capital Plan	$15,000	$15,400

FY11 Program Accomplishments

FY11 Program	Work Planned	Work Accomplished	Explanation for Variance
• Spacer Damper FY08-12	680 miles	607 miles	Transition to a new spacer cat ID delayed materials and projects in September
• Insulator Replacement	60 miles	87 miles	Still within stretch target
• Bird Dung Deflectors	4 Towers	11 Towers	Opportunity presented itself to do more
• Tower Relocations	2 Towers	0 towers	Re-scoping and engineering design necessary, delaying construction

Sustain Steel Plan vs. Actuals, FY11 ($000s)		
	FY 11 Plan	**FY 11 Actuals**
Spacer Damper FY08-12	$15,000	$8,600
Insulator Replacement	$6,600	$5,100
Bird Dung Deflectors	$100	$300
Urgent Tower Relocations	$0	**0**
Total Capital Plan	$21,700	$14,000