

2014 Biennial Report to the Congress

as required by

**The Coin Modernization, Oversight, and
Continuity Act of 2010 (Public Law 111-302)**



**United States Mint
Department of the Treasury**

December 2014

BACKGROUND

The Coin Modernization, Oversight, and Continuity Act of 2010, Public Law 111-302 (Act) (Appendix 1) authorizes the Secretary of the Treasury (Secretary) to conduct research and development (R&D) on alternative metallic materials for all circulating coins with the goal of reducing production costs. The Act also requires the Secretary to provide a biennial report to Congress on the status of coin production costs and analysis of alternative content.

As required by section 3 of the Act, each biennial R&D report must address the following three areas:

- I. Production Cost Analysis: The Act requires the Secretary to analyze “production costs for each circulating coin, cost trends for such production, and possible new metallic materials or technologies for the production of circulating coins.”
- II. Recommendations for Changes to Coin Composition: The Act requires the Secretary to provide “detailed recommendations for any appropriate changes to the metallic content of circulating coins in such form that the recommendations could be enacted into law as appropriate.”
- III. Recommendations for Changes to Coin Production: The Act requires the Secretary to provide “recommendations for changes in the methods of producing coins that would further reduce the costs to produce circulating coins, and include notes on the legislative changes that are necessary to achieve such goals.”

The United States Mint (Mint), a bureau of the Department of the Treasury, submitted its first biennial report in December 2012 and since then has continued its R&D on potential change to coin compositions as well as alternative manufacturing methods that would further reduce the costs to produce circulating coins. This report is the second biennial report as required by the Act.

SUMMARY

The Mint delivered 10.7 billion new coins to the Federal Reserve Banks (FRBs) in Fiscal Year (FY) 2013 – a 17.6 percent increase from FY 2012. In FY 2014, the Mint delivered 13.0 billion new coins to the FRBs – a 21.9% increase over FY 2013. Concurrently, the Mint reduced manufacturing costs. Overall, as a result of increased production volumes, Mint production cost reductions, Mint overhead cost reductions, and lower metals prices, from FY 2011 (when the Act became law) through FY 2014, the production cost of the one-cent coin (penny) has decreased 31.1 percent to \$0.0166 from \$0.0241; the production cost of the five-cent coin (nickel) has decreased 27.6 percent to \$0.0809 from \$0.1118; the production cost of the dime coin (dime) has decreased 30.8 percent to \$0.0391 from \$0.0565; and the production cost of the quarter-dollar coin (quarter) has decreased 19.7 percent to \$0.0895 from \$0.1114 (Appendix 2).

Since submitting its first biennial report, the Mint has significantly increased its outreach to those stakeholders potentially affected by changes to the metallic composition of the nation’s coinage. Through its outreach, the Mint learned that coin stakeholders have concerns that new coins with alternative metal compositions may have properties that are different from our current circulating coins. The circulation of same denomination coins with different metal compositions creates unique challenges for the various coin

stakeholders. Specifically, any change to the weight, shape, and most importantly the electro-magnetic signature (EMS) used to validate current circulating coins in coin acceptors would require equipment changes, potentially costing stakeholders between \$2.5 billion and \$6 billion. In addition, many industry stakeholders implored that no changes be made to the quarter because of its extensive use in many coin-accepting industries (e.g., vending, laundry, amusement, and parking). Many stakeholders asked that we consider the significant cost to the industry (\$2.5 billion - \$6 billion) compared with the projected government savings achieved by manufacturing circulating coins with an alternative metal composition (\$5 million - \$57 million annually). An analysis of comments from the coin industry stakeholders is included in Appendix 3.

Since passage of the Act, the Mint conducted extensive R&D on potential alternative metal compositions for circulating coins. During initial R&D efforts, the Mint tested twenty-nine different metal formulations. Of these metals formulations, the Mint focused its R&D efforts on six metal compositions. Since the last biennial report in December 2012, the Mint conducted extensive testing of these six compositions, as well as initial testing of materials that show potential to duplicate the existing weights and EMS of current United States coinage. One of the six compositions, the 80 percent copper and 20 percent nickel (80/20) alloy offers nearly identical weights and EMS as the current nickel, thus eliminating the impact on coin industry stakeholders. The Mint needs to conduct further R&D testing of the 80/20 alloy before confirming the use of the material as the outside layer for the clad metal composition of our circulating dime and quarter coins. However, the 80/20 alloy results in only modest material savings of approximately three percent (\$5.0 million annually using 2014 production volumes). Other compositions that may match the weight and EMS of current coinage, but provide additional savings beyond the 80/20 alloy, are currently undergoing testing that should conclude in 2015.

The other five alternative metals compositions are nickel-plated steel (NPS), multi-ply-plated steel (MPPS), stainless steel, copper-plated zinc (CPZ), and tin-plated copper-plated zinc (TPCPZ). Of these, only the steel-based coins demonstrated acceptable wear characteristics. These steel-based alternatives offer savings of 15-20 percent (approximately \$57 million annually) compared to 2014 costs. However, these steel-based alternatives require the coin stakeholder industry to make changes to recognize both new and existing coin characteristics because the two types of coins would co-circulate. Significantly, the EMS range for these steel-based compositions introduces the potential use of low-value steel coins from other countries in coin acceptance machines in lieu of higher value United States denominations, particularly the quarter.

At this juncture, there are several possible options to alter the metallic compositions that would lower the costs of United States coins, but the Mint does not recommend adopting any of these options until ongoing research is completed on a promising alternative that has the potential to duplicate the weight and EMS of existing coinage. The Mint plans to continue this research in 2015. Appendix 4 is the comprehensive technical report of the Mint's R&D efforts since the submission of the 2012 biennial report.

Regarding potential changes to coin production, the Mint, as demonstrated through its reduction in manufacturing costs, seeks continuous improvement in its production of circulating coins. In addition, the Mint investigated two alternative methodologies to produce blanks for coinage operations. The first alternative methodology involved the use of a laser to produce coin blanks. Although lasers potentially

could create coin blanks, none of the analyses showed a strongly favorable economic outcome for laser blanking. A second initiative identified a die-blanking with a push-back system, which could eliminate the expense of on-site annealing. The push-back system is very similar mechanically to the Mint's current die-blanking system and would be expected to have a low capital investment. The Mint plans to conduct additional study of the push-back die blanking system and to evaluate this equipment change in conjunction with its annual capital budget process.

Production Cost Analysis

In both FY 2013 and FY 2014, orders for new coins by the FRBs increased for the penny, nickel, dime, and quarter. In FY 2009, the Mint experienced a significant decline in FRBs coin orders and accordingly reduced its manufacturing operations at Philadelphia and Denver from three eight-hour shifts to two ten-hour shifts per day. Without increasing staff, the Mint is now producing circulating coins at the pre-FY 2009 levels with two shifts instead of three.

Since the last biennial report, circulating cost of goods sold increased 17.8 percent in FY 2013 over FY 2012 with another increase of 13.5 percent in FY 2014, mainly due to increased volumes. A decrease in the base metal spot prices for copper, nickel, and zinc on the metals market saved the Mint about \$1.9 million in FY 2013 compared with FY 2012. In FY 2014, base metal spot prices declined over FY 2013 for copper (6.9 percent) while the price of zinc and nickel increased (8.4 percent and 3.9 percent, respectively). As a result, the Mint saved \$28.8 million in FY 2014 compared with FY 2013. In addition, the Mint reduced overhead costs 3 percent at the Denver and Philadelphia Mints in FY 2013 compared with FY 2012. The Mint also controlled indirect costs in FY 2014, allowing the increased shipments to generate more seigniorage. Plant costs at the production facilities at Denver and Philadelphia increased only 1.7 percent (excluding a one-time establishment of an allowance last year for supplies of \$6.7 million), despite the 21.9 percent increase in coin production. General and administrative costs increased slightly with increased research and development expenses.

With production of the circulating dollar coin suspended early in FY 2012, the Mint anticipated seigniorage to be lower in FY 2013; however, due to increased demand for the quarter by the FRBs seigniorage exceeded the FY 2012 amount. As a result, the seigniorage per dollar issued performance increased to \$0.24 in FY 2013 from \$0.21 in FY 2012. Again, due to an increased demand for the quarter and the decrease in metal costs in FY 2014, the seigniorage per dollar issued performance increased to \$0.37 in FY 2014.

Coin Industry Stakeholder Outreach

In July 2013, through the Department of the Treasury, the Mint established the Office of Coin Studies to develop a more in-depth outreach to coin industry stakeholders in an effort to understand how circulating coins produced with alternative metal compositions might affect commerce. The process included conference calls, webinars, conference presentations, and electronic outreach utilizing e-newsletters and e-magazines. The Office of Coin Studies created, and continues to maintain and expand, a database on industry stakeholders, developed and implemented an industrywide stakeholder outreach meeting, fostered communication between industry groups, and created and sustained a continuous feedback loop between industry stakeholders and the Mint. In addition, Mint staff encouraged and participated in a

number of meetings with associations that represent industries dependent on circulating coins for their business operations. The Mint published a *Federal Register notice* (FRN), soliciting coin industry comment, in April 2014.

Following the heightened outreach program, the April 2014 FRN generated 962 comments, of which 99 percent received were directly responsive to the request for comment. Among the 962 contributors are the American Banking Association (ABA), National Armored Carrier Association (NACA), National Bulk Vending Association (NBVA), Coin Laundry Association (CLA), Multi-Housing Laundry Association (MHLA), American Amusement Machine Association (AAMA), Amusement & Music Operators Association (AMOA), National Parking Association (NPA), International Parking Institute (IPI), a newly formed coalition called “Don’t Change Our Change” (DCOC) representing 226 small businesses, and over 700 additional medium and small businesses. Based on comments from the coin industry stakeholders, a transition to an alternative metal with co-circulate characteristics would cost between \$2.4 billion and \$6 billion to accommodate new coins.

The Act specifically requires that the Secretary shall consider factors relevant to the ease of use of and ability to co-circulate new coinage materials, including the effect on vending machine and commercial coin processing equipment and making certain, to the greatest extent practicable, that any new coins work without interruption in existing coin acceptance equipment without modification. From responses received and initial analysis, the Mint segmented feedback by the role each contributor plays within the industry. The three primary roles are: (1) *equipment manufacturers*, companies involved in the manufacture of coin processing and acceptance equipment; (2) *logistics*, those whose primary role involves the distribution, packaging and storage of coin; and (3) *commerce*, any business that is dependent on coin in the conduct of business to include retailers, vending machine operators, transit operators, and municipalities managing parking garages and/or meters.

Equipment manufacturers emphasized that any change that alters size, design, or content of a coin without comprehensive consultation and coordination with the industry could harm the economy. Specifically, if coin design or material content changes are orchestrated hurriedly without regard to the equipment and other stakeholders, the currently reliable United States coin circulation infrastructure could be adversely affected or fail altogether. In addition, co-circulating same denomination coins with different weights would be ruinous for coin weighing technology, as co-circulating coins would have to be separated for counting.

Logistics sector includes depository institutions (banks) and the armored carrier industry. The ABA recommended no changes be made to the metallic composition of U.S. coinage in circulation at this time. The ABA cited changing the weight or dimensions of a coin would present serious challenges to banks because bulk coinage is counted by weighing bags of coins. If the weight changes in new coins, then banks and armored carriers would need to keep new and old coins separate. This would slow the counting process and would increase personnel costs. The ABA went on to note changes to circulating coins would result in the additional cost for new equipment and higher charges for services provided to businesses and consumers. In addition, the ABA raised concerns about changing the EMS of coins, as this would result in a similar outcome. The NACA recommended no changes be made at this time to the sizes or metallic composition of currently circulating U. S. coins. The NACA also expressed concern that an alteration of coins’ weights could eliminate weighing as an option for bulk verification and

significantly and negatively influence productivity. Alternative metals resulting in heavier coins would affect transportation costs through higher fuel costs due to the increased weight and the potential of multiple trips to service customers due to weight limits as well as wear and tear on coin handling equipment and armored vehicles.

Commerce sector comments received by the Mint included NAMA, NBVA, CLA, MHLA, AAMA, AMOA, NPA, IPI, DCOC, and over 700 additional medium and small businesses. NAMA stated that the Act requires consideration be given to the impact on vending. The NAMA feedback indicated the most significant potential impact of a change to circulating coin composition would be to those industries that use machines that accept coins for automated payments. These machines rely on acceptors that discern the EMS, weight, and shape of each coin to identify its value. NAMA estimates there are seven million vending machines across the country and the cost of these changes could amount to \$3.5 billion for the vending industry, negatively affecting the entire vending and food service channel and its consumers.

NBVA, CLA, MHLA, AAMA, and the AMOA opposed changing the composition of the quarter. Specifically, changing this coin's weight, EMS, or size would have immediate and significant impacts on these industries. NPA provided feedback relating to small business owners, as well as public entities. NPA noted the parking industry would be particularly disadvantaged by changes because the majority of commercial operators are small to medium sized, privately held firms. These companies would be faced with costly decisions to automate operations, or even close their doors. For larger operations, both public and private, the cost of new equipment, training, software, and changes to business systems across their operations would be a financial and operational burden. IPI noted concern regarding the composition of new coins relating to content, weight, dimension, and EMS. Regarding conversion costs, without the benefit of knowing the actual changes being considered to circulating U.S. coins, IPI estimated that retrofitting parking meters could cost \$200 - \$300 per machine, excluding labor. The burden for the owners, both private and municipalities, could exceed \$400 million.

DCOC is a coalition of associations and organizations that primarily represent small business owners, their suppliers, distributors, employees, and customers, all of whom would be affected by a change in coin composition. There were 226 letters received from this group. The DCOC letter specifically noted, "changes to coinage will create an added expense, at best, and could mean the difference between a thriving or failing business for many coalition members." The letter further noted there are approximately 10 million coin-operated machines with cost estimates of \$100 to \$500 per machine to retrofit depending on the requirements. Further impact could include: (1) co-circulation resulting in unknown consequences; (2) uncertainty associated with the length of a transition period; (3) increased service of equipment; and 4) the savings recognized from the composition change would be offset by a reduction in tax revenue.

R&D Alternative Metals

After Phase I concluded in December 2012 with the issuance of the biennial report, the Mint continued its research into alternative metals, rejecting some of the materials recommended in that report, and identifying six materials that would form the major effort for continued testing in Phase II. Beyond those six compositions, however, the Mint continued to consider and evaluate other, potential, alternative materials.

For Phase II testing, the following materials were evaluated on the coins indicated:

	Material	Composition	Tested On
1	Copper-plated zinc (CPZ)	Copper plated on zinc (identical to current one cent)	Nickel
2	Tin-plated CPZ (TPCPZ)	Tin plated on copper plated on zinc	Nickel
3	Nickel-plated steel (NPS)	Nickel plated on low-carbon steel	Nickel Quarter
4	Multi-ply-plated steel (MPPS)	Nickel plated on copper plated on nickel plated on low-carbon steel	Nickel Quarter
5	Stainless steel	Austenitic (non-ferromagnetic) stainless steel, monolithic	Nickel
6	80/20 cupronickel (80/20)	80 percent copper, 20 percent nickel, monolithic	Nickel*

* 80/20 alloy was only tested on the nickel, but was expected to be clad to copper for higher denominations if it passed.

The Mint chose the top five listed as “co-circulate” materials, which would not have the same EMS or piece weight as the material of same-denomination coins that are currently in circulation (current material). The Mint chose the 80/20 alloy as a “seamless” material, which matches the current material’s EMS and weight, and has no appreciable impact on the coin-accepting industry.

The Mint purchased all materials except stainless steel in variability lots, which were laboratory-produced and contained 500–2,000 pieces made to specifications to provide the expected range of material in production. Those materials that passed the variability lot testing were then purchased in pre-production lots, which were much larger, typically about two million pieces. Pre-production lots were produced on the supplier’s normal manufacturing lines over separate production runs to evaluate material that would be representative of actual production.

During variability testing, materials were processed through progression strikes to show how varying strike force (in metric tons, or tonnes) would affect the material’s detail (“fill”) as compared with the current coins. The Mint also put test pieces through a two-week wear test, a steam test designed to test the material’s resistance to color change, and various other tests such as conductivity, hardness, and EMS. Then, the materials had to pass a Go/No-Go determination based on seven criteria.

TPCPZ and CPZ both failed their Go/No-Go determinations because of poor results on the wear test. NPS and MPPS passed their Go/No-Go determination (although the security requirements of the quarter had not been finalized at that time), and the Mint purchased those materials for pre-production testing.

The original 80/20 alloy’s EMS did not match that of the current material. However, a slightly modified version of the 80/20 alloy, which substituted manganese for some of the nickel to achieve the conductivity and EMS of the current material, showed promise. Accordingly, the Mint procured 500 pieces of this modified 80/20 alloy for evaluation through progression strikes and for wear and discoloration tests. The Mint also tested the modified 80/20 alloy’s EMS at three different external coin

acceptor manufacturers that all confirmed an EMS match with the current material. The Mint determined that modified 80/20 alloy passed its Go/No-Go determination and, accordingly, it purchased additional quantities for pre-production testing.

The Mint purchased NPS and MPPS in nickel and quarter coin configurations and the modified 80/20 alloy in a nickel coin configuration for the pre-production testing. Initially, NPS and MPPS proved to have poor striking qualities in the variability testing. However, the Mint consulted with The Royal Mint (RM) and the Royal Canadian Mint (RCM), both of which have experience with these cold-rolled, low-carbon, plated-steel materials, and identified various changes to resolve these issues. After the consultations, the Mint sent nonsense dies (dies that are comparable to those used for regular coin, but contain different devices and nonsensical inscriptions to clearly distinguish their resulting products from genuine coins) to RM and RCM to benefit from their expertise with physical vapor deposition (PVD) coatings for dies used on their products that must withstand the severe abrasion associated with nickel plating on both of the plated-steel materials.

The RM and RCM sent to the Mint quantities of both materials, which showed improvement, but there were problems with die life and fill. After more interaction with the RM and RCM, the Mint received pre-production lots and conducted full tests on both plated-steel materials. The die life still proved significantly less than with the current material. The Mint determined that noticeable changes to the coin aspects (including adjustment to the height of relief/crown, smoothing design features, softening letters, and less-detailed images in general) would be needed to improve coinability. In addition, planchet profiles and blank lubrication would need optimization. The tests suggested that the plated-steel materials will not surpass or even match the current material in coinability.

The Mint also investigated stainless steel as a co-circulate option, either as a monolithic material for the nickel, or as a clad material for the dime, quarter, and half-dollar. The security requirements of the quarter and higher denominations make this easily counterfeited material unsuitable for those denominations, though it would be feasible for the nickel. Further testing would be required to determine its feasibility for the dime.

Currently, ninety-two countries use bi-metallic materials for circulating coins. The Mint researched the potential of using bi-metallic materials for the nickel coin configuration including potentially using the current penny as the center with an outer ring made from the current nickel coin composition. The bi-metallic study recommended not using circulated or unstruck planchets of the current penny for a bi-metallic nickel coin composition. The study concluded the capital cost required for the Mint to produce bi-metallic coins would increase the unit cost of coins by approximately 0.0066 \$/coin. Consistent with observations of other countries using bi-metallic coins the study recommended the use of bi-metallic coins with a face value greater than or equal to one dollar.

The Mint is still researching other alternatives to the materials already tested in this report. Of note are coins made of a variation on “nickel silver,” a material composed of copper, nickel, and zinc that has a silver appearance. The variation, alloy C77000, is expected to yield a coin that not only has the same EMS as current coins, but like the 80/20 alloy also has a weight that falls into the acceptable variation on current coins. The Mint is partnering with the National Institute of Standards and Technology, a bureau of the Department of Commerce, to pursue an alloy development project.

The Mint is also investigating plated coins that use a silicon-steel core, not used elsewhere in the world that could have a unique EMS. Silicon steel is commonly referred to as “electrical steel” and has a similar price to low-carbon steel.

Findings and Conclusions

Two separate types of alternatives were considered during Phase II testing and evaluation. The first was a material with an EMS and piece weight that was potentially seamless with the current circulating coinage compositions (80/20 alloy). The second was co-circulate alternatives in which the EMS differed from the current material and the piece weight would vary from the current material by 4 percent or more (NPS, MPPS, Stainless steel, CPZ, TPCPZ). Potentially seamless alternatives would not require changes to the coin acceptors, but would offer only modest material savings (approximately 3 percent). Co-circulate alternatives provide much greater materials savings (approximately 20 percent), but would require significant stakeholder conversion costs to accommodate the different EMS and piece weight. Table 2-12 (Appendix 5), which is an excerpt from the Technical Report (Appendix 4) shows the estimated cost breakdown of current and alternative metals.

Seamless Material

1. A variant of today’s current cupronickel composition, termed the 80/20 alloy, which has a lower nickel content with higher manganese content, was found to be seamless when tested by three separate coin-acceptor manufacturers.¹ The Mint estimated this material would provide approximately \$5.25 million annual savings (\$3.2 million for the nickel, \$0.8 million for the dime, and \$1.25 million for the quarter) with no impact on the public or on stakeholders.
2. The 80/20 alloy matches the current material in both EMS and in piece weight, having a weight that falls within legally accepted variances for the current material.
3. Initial testing of other, potentially seamless, leaner-copper alternatives shows potential for further incremental material savings without presenting any color changes or corrosion-resistance changes.

Co-Circulate Materials

4. Plated-steel materials are a viable option for the nickel and potentially the dime, and offer approximately \$22 million to \$29 million in savings annually over current materials. Plated-steel materials for the quarter offer an additional \$25 million to \$27 million in annual savings; however, plated-steel materials have increased risks of fraud and counterfeiting, and are used in low-value foreign coins, all of which make the materials not feasible for use in the quarter. Plated-steel materials also cause a significantly lower die life, which, if not mitigated (see #6, below), could increase production and labor costs, and reduce the savings the materials might offer.
5. Stainless steel, while resistant to corrosion, has a hardness that can negatively affect its coinability. Control of cold-rolling reduction and proper annealing of the right grades demonstrated the ability to mitigate this factor, and improves the coinability of stainless steel.

¹ In testing, 80/20 alloy nickel pieces were 100 percent accepted by all three coin-acceptor manufacturers.

Production Improvement

6. The Mint explored options of adjusting the height of the relief and crown on the current coin to address unacceptable fill on some materials. However, this change introduced other issues, such as outer elements (e.g., the border) filling before inner element, or the flow of the material changing. It became clear that changes to the coin features—including adjustments to the height of relief or crown, planchet profile, smoothing of design, softening of the letters, and less-detailed images in general—must be treated as a collective system. This system involves not only the items mentioned here, but also matching planchet-die geometry; strike force; die lubrication, coating, and polishing; and other variables.

Terminated Materials

7. Testing of plated zinc alternatives CPZ and TPCPZ showed insufficient wear and durability properties for consideration on denominations other than the current penny coin's CPZ application. Additionally, TPCPZ exhibited galvanic corrosion when copper and tin, two dissimilar metals, were exposed to the environment during wear, rendering this construction unsuitable for U.S. coins aside from the penny.

R&D Changes to Coin Production

In accordance with the Act, the Mint is seeking ways to reduce the cost of producing circulating coins. The Mint investigated the technical and financial feasibility of using laser blanking in two ways that showed promise: (1) replace the current mechanical die blanking and on-site annealing with laser blanking and off-site bulk annealing; and (2) retain the on-site annealing and exchange die blanking with laser blanking.

A thorough review of the technical issues found no significant concerns. The review involved laser cutting nine different materials and making sample coin blanks. The sample blanks were characterized for diameter, burr, knit-line, edge condition, grain structure, and hardness in the area adjacent to the laser cutting. Laser cutting of the monolithic nickel coin material was found to be faster and at better edge quality than with any of the clad materials (dime, quarter, and dollar coins). Sample lots of 100 pieces of nickel, dime, quarter, and dollar coin blanks were sent to the Mint for evaluation.

A conceptual design was developed along with three-dimensional, computer-aided design images, showing how multiple lasers, working in parallel, could meet the production needs of the Mint. In addition, an environmental assessment was performed, which yielded no significant concerns.

The feasibility review included several economic analyses using a range of assumptions, but none of the analyses showed a strong favorable economic outcome for laser blanking. The production capacities of laser blanking machines that are equal to the current die blanking machines are economically unfavorable. Perhaps in the future, if lasers cut faster or become less expensive, that situation might change, but currently a transition to laser blanking does not appear to offer financial benefits.

In the course of this study, the Mint identified a promising alternative to laser blanking called die blanking with a push-back system, which could eliminate the expense of on-site annealing. This system is very similar mechanically to the current die blanking and the capital investment appears to be low.

Either laser blanking or push-back blanking could eliminate on-site annealing, but only push-back blanking is likely to result in an overall cost savings.

Conclusions and Recommendations

1. There are no alternative metal compositions that reduce the manufacturing unit cost of the penny below its face value.
2. Based on the response from coin industry stakeholders, the estimated industry cost (\$2.4 billion to \$6 billion) to accommodate an alternative metal for circulating coins that incorporates a change to the weight or EMS characteristics far exceeds the estimated annual government savings (\$46 million to \$57 million) (Appendix 5).
3. The coin industry stakeholders overwhelmingly recommended no change to the quarter.
4. The Mint does not recommend the use of copper-plated zinc or tin-plated copper-plated zinc for circulating coins with a face value equal to or exceeding five-cents. In addition, the Mint does not recommend the use of multi-ply-plated-steel or nickel-plated steel for circulating coins with a face value equal to or greater than twenty-five cents.
5. Based on the coin industry response as well as the Mint's R&D results, the Mint should evaluate the potential cost savings (\$5.25 million annually) of alternative metal compositions that meet the seamless criteria of no change to the weight or EMS characteristics for circulating coins and its corresponding effect on the coin stakeholders.

Next Steps: Planned Areas of Further Study

1. Continue seamless 80/20 alloy testing and evaluation
 - a. Continue larger-scale testing of modified 80/20 alloy and develop a final specification that can be utilized by current and other strip suppliers.
 - b. Conduct feasibility, variability, and pre-production testing on cladding modified 80/20 alloy to a copper core as an alternative for the clad denominations of dime, quarter, and half-dollar coins. The direct cost savings from this change would be limited, but continuing to clad these coins with the same alloy used for nickel would streamline material production.
 - c. Report findings before the end of FY 2015.
2. Pursue seamless alloy development

Continue alloy development of other, potentially seamless, leaner-copper alternatives to provide opportunity for additional incremental materials savings without affecting coin acceptors and coin processors. Initial testing indicates further opportunity for incremental material cost reductions with a composition evolving over several progressive steps.

3. Continue stainless steel R&D
 - a. Continue larger-scale variability and pre-production testing on the two stainless steel grades that we identified in the Stainless Feasibility Study as having potential for use as circulating coinage material.
 - b. Conduct testing and evaluation of monolithic stainless steel as a clad outer layer as a co-circulate material. Engineering calculations indicate this combination could exhibit a similar EMS to the current clad coins and enable the copper core thickness to be reduced, providing incremental material savings, and a reduction in the use of the more-expensive and price-volatile nickel. Its piece weight, however, would be lighter.
4. Explore production improvements
 - a. Investigate push-back blanking and determine if it is a technically feasible and cost-effective production method that would enable elimination of internal annealing on strip material.
 - b. Pursue more-structured test strikes on different coin materials, modified design aspects, and upset profile configurations to increase the Mint's understanding of the overall coin manufacturing system. These results can be utilized to improve production efficiencies on current coin materials and provide for quicker evaluation of future materials. Results from structured trials can be used to support predictive model development and reduce the need for time-consuming iterative test strikes.
5. Continue coin industry stakeholder outreach
 - a. Continue to engage the industry stakeholders regarding the Mint's R&D efforts as well as further discussions to understand the timeframes required for the industry to accommodate alternative metal coins with seamless or co-circulate characteristics.
 - b. Engage the industry stakeholders about current and future business trends affecting the use of coins.
6. Initiate studies to understand consumer behavior regarding the use of coins for commerce. Conduct public surveys and focus groups to understand consumer behavior better regarding the use of coins for commerce. This will improve the Government's understanding of, and planning for, the future of money.

Appendices

- Appendix 1: Public Law 111-302 – Coin Modernization, Oversight, and Continuity Act of 2010
- Appendix 2: Production Cost Analysis with Circulating Metal Commodity Metal Prices
- Appendix 3: Coin Industry Stakeholder Feedback Report
- Appendix 4: Alternative Metals Study Phase II Technical Report
- Appendix 5: Table 2-12. Estimated Cost Breakdown – Current and Alternative Metal