2020 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

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1. Background

The Coin Modernization, Oversight, and Continuity Act (CMOCA) of 2010, Public Law 111-302 (Act), 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, cost trends for such production, and possible new metallic material or technologies for the production of circulating coinage.

The United States Mint (Mint), a bureau of the Department of the Treasury, submitted its first biennial report in December 2012. Subsequent to that initial report, three others were submitted – in 2014, 2016, and 2018. This report is the fifth biennial report produced as required by the Act.

2. Executive Summary

Over the past 10 years, the Mint has conducted extensive testing and evaluation into alternatives that are both seamless (i.e., would work interchangeably in a vending machine with current coins) and co-circulate (offer greater materials savings, but would require changes to coin acceptors). Given the projected cost impact to the vending industry of co-circulate alternatives, the Mint has worked extensively to develop and evaluate seamless alternatives. One such seamless alternative (80/20, which is a slightly different composition with marginal material savings) has been proven across multiple denominations (5-cent, 10-cent, and 25-cent) in extensive trials, possesses the same electromagnetic signature (EMS), diameter, color, and weight, and is ready for implementation. However, the CMOCA only authorizes the Mint to conduct Research and Development (R&D), not implement. Legislation enabling the Mint to implement seamless alternatives identified and tested is necessary and strongly recommended. Treasury budget requests have requested such authority to implement seamless findings. Currently, there is legislation (Coin Metal Modernization Authorization and Cost Savings Act), which the Mint supports, that would enable a transition to seamless alternatives identified by the Mint that meet the criteria of a) lowering the cost of producing circulating coins, b) being seamless, and c) having minimal impact on stakeholders.

Details of these specific alternatives, and the denominations that they apply to, are summarized in the following report.

3. Production Cost Comparison.

The Mint manufactures new circulating coins, which supplement the Federal Reserve Bank (FRB) coin inventories and meet the needs of commerce through the Nation's banking system. Typically, the Mint's annual production of new circulating coins is the net difference between total demand for circulating coins and total deposits received by the FRB from the banking system. The FRB buys new coins from the Mint at face value. The difference between the face value and the Mint's manufacturing cost is known as seigniorage. The Mint transfers seigniorage in excess of the expenses required to support ongoing operations and programs to the Treasury General Fund to help reduce the national debt.

Fiscal year (FY) 2020 unit costs are lower than those reported in our 2018 biennial report. The unit costs for FY 2020 are: pennies, 1.76 cents; nickels, 7.42 cents; dimes, 3.73 cents; and quarters, 8.62 cents. The unit cost for both pennies and nickels remained above face value for the 15th consecutive fiscal year. While Federal Reserve orders for new coins decreased in FY 2019, orders increased in FY 2020. FY 2019 circulating coin shipments to the FRB decreased by 1.2 billion units (8.8 percent) to a total of 12.5 billion coins compared to FY 2018. FY 2020 circulating coin shipments to the FRB of 15.5 billion units increased by 3.0 billion units (24.2 percent) compared to FY 2019.

UNIT COST OF PRODUCING AND DISTRIBUTING COINS BY DENOMINATION

2020	One-Cent	Five-Cent	Dime	Quarter-Dollar
Cost of Goods Sold	$0.0151	$0.0653	$0.0326	$0.0760
Selling, General & Administrative	$0.0022	$0.0080	$0.0042	$0.0091
Distribution to FRB	$0.0003	$0.0009	$0.0005	$0.0011
Total Unit cost	$0.0176	$0.0742	$0.0373	$0.0862

2019	One-Cent	Five-Cent	Dime	Quarter-Dollar
Cost of Goods Sold	$0.0168	$0.0659	$0.0317	$0.0777
Selling, General & Administrative	$0.0029	$0.0095	$0.0051	$0.0114
Distribution to FRB	$0.0002	$0.0008	$0.0005	$0.0010
Total Unit cost	$0.0199	$0.0762	$0.0373	$0.0901

2018	One-Cent	Five-Cent	Dime	Quarter-Dollar
Cost of Goods Sold	$0.0178	$0.0659	$0.0323	$0.0778
Selling, General & Administrative	$0.0025	$0.0085	$0.0045	$0.0099
Distribution to FRB	$0.0003	$0.0009	$0.0005	$0.0010
Total Unit cost	$0.0206	$0.0753	$0.0373	$0.0887

4. Research and Development

The CMOCA authorizes the Secretary to conduct R&D on “possible new metallic materials or technologies for the production of circulating coins.” The CMOCA also specifies that before the second anniversary of its enactment, and biennially thereafter, the Secretary shall submit a report to Congress, analyzing production costs for each circulating coin, cost trends for such production, and possible new metallic materials or technologies for the production of circulating coins.

The Mint has performed research for the last 10 years to identify materials that satisfy the requirements of the Act, eliminating from consideration those that do not. As a result, the Mint has narrowed the wide field of elements and metallic alloys to several potential “seamless” alloys (meaning they would require no or minimal changes to coin-accepting equipment, but offer only incremental material savings), and a small number of potential “co-circulate” alternatives (meaning they would offer greater material savings, but coin-accepting equipment would require changes for the new coins to co-circulate with current coins) that would only see use in the 5-cent coin or in the 5-cent and dime coins[1].

In December 2012, the Mint submitted to Congress the initial biennial report that outlined potential alternative metals to replace the current coinage materials/construction. Alternatives were categorized as either potentially seamless or co-circulate. Subsequent reports in 2014, 2016, and 2018 have shared detailed results of testing and evaluation and identified which are viable candidates. Since the last report, no new alternatives have been identified, but evaluation and testing of identified alternatives have continued during this most recent two-year period. In addition, work progressed on production improvements. A summary is provided below.

A. Alternative Materials

The materials that underwent more extensive evaluation during this period are listed below with more detail as to what alternative, the denominations it applies to, and its readiness for implementation:

- 80/20: A seamless variation on the present cupronickel (75% copper (Cu)/25% nickel (Ni)), with more Cu, less Ni, and some manganese (Mn). Nominal composition of 77% Cu, 20% Ni, and 3% Mn that would be applicable to the 5-cent, 10-cent, 25-cent and 50-cent.

- C99750T-M: A leaner potentially seamless alloy developed jointly with the National Institute of Standards and Technology (NIST), which contains less Cu and Ni and substitutes zinc (Zn) and manganese (Mn). Nominal composition of 50.75% Cu, 14% Ni, 33% Zn, and 2.1% Mn. This alloy represents what we believe to be the leanest or lowest material cost seamless alternative possible to replace the monolithic 5-cent and be clad on higher denominations.

- Nickel Steel: A monolithic alloy developed by the Mint, which is austenitic (not attracted to magnets) and a less expensive co-circulate alternative to stainless steel. Nickel content is 25%, with the balance being lower cost iron and some manganese vs a higher cost copper.

- Nickel Plated Silicon Steel: An alternative to the commonly used nickel or multi-ply plated steels in the world. This option could provide a co-circulate alternative with a distinguishable EMS and therefore less opportunity for substitution with other commonly available plated steel coins which are plated on low carbon steel.

- Copper Plated Steel (CPS): An alternative to the Copper Plated Zinc (CPZ) Penny. This alternative could be an option that presents minimal impact to stakeholders with the same appearance, seamless dimensions, and weight, but different EMS (which is not relied on

[1] Application of these alternatives is not recommended on medium-to-high value coins due to concerns with potential for counterfeit and fraud.

by coin accepting equipment for the one-cent) so would be considered a seamless alternative.

A cost comparison table provided as attachment 1 estimates the material cost, total unit cost, and annual savings versus current coin compositions. The unit cost projections and resultant annual savings are very sensitive to fluctuations in metal cost and production volumes[2] so the estimates should be used as relative or directional and not budgetary.

With the prior research and the continued evaluation this period, the following table summarizes all the identified potential alternatives evaluated by the Mint, whether seamless/co-circulate, the denominations they are applicable to, and the testing status or readiness for implementation:

Alternative	Seamless/Co-Circulate	Denominations	Testing Status/Readiness for Implementation
80/20	Seamless	5¢, 10¢, and 25¢	Full First Article qualifications of Mint production and current supplier capability complete with external validation by three coin acceptor manufacturers (CAMs). *Fully ready for implementation pending legislative authority.*
C99750T-M	Potentially Seamless	5¢, 10¢, and 25¢	Small scale testing completed with samples validated by three external CAMs. Further small scale testing was completed to define alloy composition and coin blank dimension specifications. *Larger scale tests would be required to confirm production capability and confirm seamless.*
Copper Plated Steel	Seamless (since EMS is not used for the one-cent)	1¢ only	Small scale testing underway to define coin blank specifications and design modifications. *Larger scale tests planned for early 2021 to determine coining production*

[2] Since a portion of the unit costs are distributed fixed production costs, overhead, and General & Administrative, changes in annual coin volumes can significantly affect the unit cost and projected savings.

			impacts and determine economic potential.
Multi-ply Plated Steel (MPPS)	Co-Circulate	5¢ and 10¢	Large pre-production scale testing completed, would need First Article qualification. *No additional testing or evaluation this period.*
Nickel Plated Steel (NPS)	Co-Circulate	5¢ and 10¢	Large pre-production scale testing completed, would need First Article qualification. *No additional testing or evaluation this period.*
Nickel Plated CPZ (Copper Plated Zinc)	Co-Circulate	5¢ and 25¢	Small scale feasibility testing completed with no external CAM testing. *This alternative has been eliminated from further consideration.*
R52 Stainless (monolithic)	Co-Circulate	5¢ only	Small scale feasibility testing completed with limited external CAM testing. *No additional testing or evaluation this period.*
Nickel Plated Silicon Steel	Co-Circulate	5¢ and 10¢	Small scale feasibility testing completed with limited external CAM testing. *No additional testing or evaluation this period.*
Nickel Steel (monolithic)	Co-Circulate	5¢ only	Small scale feasibility testing completed with limited external CAM testing. *Larger scales test planned.*

The first material (80/20) in the above chart has been determined to be seamless, meaning that it is intended to work in current coin-accepting and handling equipment without modification. Extensive testing has been conducted on 80/20 monolithic 5-cent, and 80/20 clad 10-cent and 25-cent denominations (half-dollar coins were not tested[3]), including comprehensive 1st Article qualification of both current strip suppliers and both circulating production facilities. In

[3] Testing for 80/20 was completed only on the dime and quarter-dollar, given the same clad construction the testing can readily be extrapolated to the half-dollar.

addition, the Mint conducted testing with three major CAMs to validate that the 80/20 is seamless with current U.S. cupronickel and cupronickel clad coins. Those tests utilized the CAMs' equipment and compared the alternative pieces to ones pulled from production as well as each CAM's acceptance windows. The C99750T-M material is potentially seamless for the 5-cent piece. It has the same EMS, dimensions, and average piece weight as the current material. C99750T-M is also theoretically a potential seamless replacement for the cladding material of the dime, quarter-dollar, and half-dollar, but no actual test has been undertaken as of yet. Given that the major portion of clad coins is the copper core, the material savings from any change in the cladding composition are not significant. More development work is needed, along with larger scale testing, to establish C99750T-M as a viable seamless alternative; this is expected to take several years.

Copper Plated Steel (CPS) has been identified as a potential alternative to the Copper Plated Zinc (CPZ) penny. Market research and technical evaluations began in the 2nd quarter of Calendar Year (CY) 2020 to estimate unit cost, manufacturer's capacities, and technical feasibility. This alternative could be an option with seamless dimensions and weight, but different EMS (steel substrate – ferrous, magnetic; zinc substrate – nonferrous, non-magnetic). Market research conducted during the initial study in 2010-2012 had determined that coin processors validate the penny by coin dimensions and not EMS, so this alternative could be considered seamless (same diameter, weight and visual appearance). It is not expected to yield significant cost savings, as differences in metals costs between zinc and steel are offset by higher fabrications costs associated with plated steel planchets. It would, however, enable multiple suppliers, providing a longer term economic advantage. Multiple suppliers also provide the Mint with lower contingency risks, as issues impacting one supplier with a single production facility would not affect the entire blank supply chain.

The remaining materials in the summary are co-circulate alternatives, meaning they do not have the same EMS, or piece weight, as that of the current U.S. coinage material. Co-circulate materials offer greater material savings, but would require modifications to coin-accepting and handling equipment.

The co-circulated materials listed—NPS, MPPS, and R52 Stainless—have been tested and evaluated, and details have been provided in earlier reports.

Earlier versions of Nickel Plated CPZ were evaluated during large pre-production scale testing and judged not suitable for circulating coinage. This alternative demonstrated excessive deformation when subjected to accelerated wear testing relative to cupronickel and cupronickel clad. During 2019, two redesigned Nickel Plated CPZ alternatives were presented to the Mint for evaluation. These modified Nickel Plated CPZ coin blanks utilized harder zinc alloys as substrates to resist excessive deformation. After stamping trials and wear testing, these alternatives were again judged not suitable, due to poor design fill (one zinc substrate was too hard) or excessive wear test deformation (one zinc substrate was too soft). Nickel Plated CPZ has been eliminated from further consideration.

There were two co-circulate alternatives developed by the Mint as unique alternatives which would reduce the opportunity for substitution or fraud from other world coins. Nickel Steel is a lower cost alternative to stainless steel that was tested earlier. It is also austenitic (non-magnetic) with superior wear and corrosion resistance as compared to the current 5-cent. Its EMS and the monolithic construction mean it would be appropriate only for the 5-cent coin[4]. The Mint determined that Nickel Steel is viable for coining based on small scale testing. More extensive testing is planned to fully assess its coinability and production capability. In addition to its improved coinability, Nickel Steel does not exhibit the mottled or orange peel appearance associated with the similar R52 stainless steel alternative tested and reported earlier.

The other potentially unique co-circulate alternative developed by the Mint is Nickel Plated Silicon Steel. The distinctive conductivity characteristics of silicon steel (also referred to as electrical steel), as compared to the low carbon steel used by other countries as a core material for plated coins, could provide a means of discriminating from the more commonly available nickel or multi-ply plated coins used by many countries. More extensive testing would be required to fully assess its viability.

B. Production Improvements

The coin striking process is a whole system, no part of which can be changed without affecting another. These aspects include not only die shape and stamping force, but also level of detail, sharpness of transitions, and relief height in the coin's design; overall curvature of the coins' faces; and the upsetting process (which deforms the blank's material to the planchet's rim). The Mint considers these factors in optimizing the coin design.

During this current study, the Mint conceived an optimized system for the 5-cent coining process that can increase die life by modifying upset profiles and practices, as well as changing the geometry of the dies themselves together with subtle changes to the dies' designs that do not negatively affect the approved design or appearance. Specifically, matching planchet upset and die curvatures will reduce coining pressures around the coin edge, producing more uniform normal pressures. This "matched system" would enable coining presses to use less stamping force and still obtain optimal detail in the coins produced using current coinage materials. Less stamping force results in longer die life. Production testing has confirmed the effectiveness of this approach, and implementation is currently in progress. While making the production of the 5-cent more efficient, the impact of increased die life on unit cost is not significant and will not bring the cost under face value.

Matching planchet and die curvatures will also be beneficial when considering alternative materials, which in many cases are harder than current cupronickel. Greater hardness increases the coins' wear resistance, but the striking tonnage must be increased to get the same level of detail in the new coins as in the current ones. This greater striking pressure would reduce the die life and increase the stamping process cost. After the upset and die modifications, these harder new materials could be stamped to get the same image detail with the same tonnage as current production.

The Mint saw promising results when the "matched system" was used on the current coinage material, alternative materials, and also with pushback-blanked material (as opposed to conventional blanked material). Beyond that, the optimization also shows great promise with other circulating denominations regardless if alternative materials or current materials are used.

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[4] If both denominations were made from the same monolithic material, the larger 5-cent could be counterfeited into the smaller but higher value 10-cent.

The Mint contracted with an independent company to perform a study on the formation of the coins' rims in the optimized design. The contractor used a prototype upsetting tool and tested several different profiles and methods of upsetting blanks and determined that a tapered upset with a concave facing formed the best rims of coins, and that tapered upset with a convex facing was nearly as good. Continued testing and evaluation are in progress.

Push Back Blanking (PBB) is a blanking process which cuts blanks from coils of material annealed by an external supplier as opposed to the current process of cutting the blanks from the cold rolled coil first (the harder cold-rolled strip facilitates blanking with our conventional blanking process, a special blanking die is necessary for the "softer" annealed strip) and then annealing the blanks internally. While a viable coin production process, it was not significantly more cost effective than our current production methods and was not pursued.

C. Findings

The Mint continued testing and evaluation of both seamless and co-circulate during this period. In addition, the Mint continued to develop and evaluate of several concepts to improve the production of circulating coin.

a) Seamless Materials

1. After extensive testing, the Mint determined 80/20 to be a seamless alternative for producing 5-cent (monolithic), 10-cent, and 25-cent (when bonded to a copper core) circulating coins that matches the current materials' key characteristics of EMS, color, and piece weight. The Mint completed qualification of the strip suppliers and the Mint production processes and three major CAMs completed external validation. Material savings would be incremental. Given the extensive testing already completed, implementation would be projected six to 12 months after enabling legislation.

2. The Mint continued to test C99750T-M, a potentially seamless alternative developed by the Mint, with small scale trials internally and CAM validation externally. It shows promise of being able to further reduce the material costs while still being able to function in current coin-accepting and -handling equipment without modification. Lots of C99750T-M of varying compositions and gauge thicknesses were procured and evaluated to more fully define alloy composition and blank dimensional specifications. The Mint intends to conduct larger scale testing and development to determine if C99750T-M is a viable seamless alternative, both monolithic (5-cent) and clad (10-cent and 25-cent).

b) Co-Circulate Materials

1. The Mint developed two unique co-circulate alternatives, Nickel Steel and Nickel Plated Silicon Steel, which had completed initial testing to confirm coinability and coin recognition/sorter signature.

2. During this reporting period, the Mint began development of nominal and tolerance composition specifications for a Nickel Steel alloy in preparation for larger scale testing.[5] Additional work is needed during larger scale testing to develop blank finishing and lubrication processes for this unique alloy. Process development work and larger scale testing is expected to take three years.

3. CPS Penny market research and technical evaluations are underway to estimate unit cost, manufacturer's capacities, and technical feasibility. If this project is determined to be economically feasible, larger scale stamping trials will be conducted to assess impacts on die life and production practices. This is expected to be completed in one year. Use of CPS will not enable the cost of the penny to be under face value. While not expected to yield significant savings, use of CPS versus the current CPZ could provide a wider supplier base with associated flexibilities and contingency protection versus the current single supplier/single production facility for CPZ.

c) Production Improvement

1. Tests involving changing the geometry of the 5-cent dies, together with subtle changes to the dies' designs that do not negatively affect the approved design or appearance, have shown improved die life in production trials. The Mint intends to introduce subtle design changes in future circulating 5-cent production (CY 2021) and migration to other denominations as appropriate.

2. The Mint has completed structured trials with various rimming profiles on the 5-cent coin. The results show promise and can yield incremental efficiencies in the production of circulating coin and other Mint products, so development work should continue. The Mint intends to continue small-scale coining trials followed by production-scale die life testing. Objective data gathered during these coining trials will be used to develop a Finite Element Analysis (FEA) model to reduce the need for as many physical trials in the future and enable the application of the optimization to other Mint products.

D. Conclusions

In conclusion, while the CMOCA allows the Mint to conduct R&D on alternative metallic materials for all circulating coins with the goal of reducing production costs, it does not give the Secretary the authority to make any changes to the alloy composition of any of the circulating coins. After researching various alternative compositions, the Mint has identified one seamless alternative that is ready for implementation and is pursuing other potentially seamless alternatives. To realize these savings, the Mint requires a legislative change that gives us flexibility to seamlessly change the composition of alternative metals for all circulating coins. Specifically, we need legislative changes that give the Secretary the authorization, and the flexibility, to implement the seamless changes indicated in this report,

[5] Steel process companies have been solicited to supply small quantity lots of annealed Nickel Steel coin blanks in varying compositions to define nominal and tolerance specifications; however, this development work has been constrained by difficulty locating a steel process company capable of supplying small quantities of this unique alloy.

which helps the Mint to realize incremental material savings with little or no impact to stakeholder industries or the general public.