Electroless Nickel Troubleshooting Guide

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Problem

1. **Possible Causes**
    a. Suggested action to be taken

No Deposition (EN Bath will not plate)

1. **Low Temperature**
    a. Measure the bath's temperature with a calibrated thermometer and increase it to it's proper range (generally 185-195F or 85-90C)
    b. Calibrate, repair or replace the temperature controller if necessary
    c. If electrically heated, check that the voltage, current, and resistance are correct
    d. If steam heated, check the steam supply, including solenoid, strainer and trap for proper operation
    e. Ensure that the temperature sensor is in the solution and not damaged or leaking
    f. Measure the temperature of the agitation air, and if necessary preheat the air

2. **Low pH**
    a. Measure the baths pH with a calibrated pH meter and increase it ti it's proper range (generally between 4.8 and 5.2 pH) with 50% ammonia or potassium carbonate
    b. Recalibrate the pH meter or check the accuracy of pH papers used
    c. Eliminate any sources of acid drag in, such as blind holes and poor rinsing
    d. Confirm that the proper ratio of hypophosphite to nickel replenisher is being used (for self pH regulating baths)

3. **Very low nickel or reducer content**
    a. Analyze the bath's nickel and reducer content and increase them to their proper range
    b. Check the EDTA solution used for nickel titrations against a standard to ensure it's accuracy
    c. Ensure that only deionized water is used for nickel titrations
    d. Ensure that the plating tank's volume, used to determine replenishment amounts, is correct

4. **Contaminated bath**
    a. Analyze the solution for poisonous metals (stabilizers) like lead, cadmium, bismuth and tin
    b. Dummy the solution by electroless methods or electrolytically at low current density and large cathode area to remove contaminants
    c. Carbon treat the solution by circulating it through carbon cartridges or a packed filter
    d. Dispose of the bath if b) or c) are not successful and make up a new one
    e. Identify and eliminate the source of contamination. Look for: Racks or barrels that have been used in incompatible processes like cadmium; contaminated rinses; drag in blind holes or pores; parts plated with poisonous metals; incompatible maskants; drainage from adjacent equipment; steam coil leaks; impurities in agitation air or process water

5. **Bath loading very low**
    a. Check that bath loading is above 0.15 ft2/gal or 0.4 dm2/L (for some heavy metal stabilized baths)
    b. Put dummy panels into the bath to raise the loading to about 0.4 ft2/gal or 1dm2/L
    c. Increase the number of parts in the bath to obtain about 0.4 ft2/gal or 1 dm2/L

6. **Improperly made up bath.**
    a. Confirm that the bath was made up correctly. Adjust if possible, or dispose of the bath

7. **Non-catalytic part substrate.**
    a. Copper alloys and high alloy steels are not catalytic to electroless nickel plating and require special pretreatment

Low Plating Rate

1. **Incorrect thickness measurement**
    a. Repeat the test, ensuring that test specimens are clean and dry
    b. Recalibrate the micrometer or thickness test instrument using standards of proper phosphorus content
    c. If necessary, confirm thickness microscopically on a cross section of the coating

2. **Low temperature**
    a. Measure the bath's temperature with a calibrated thermometer and increase it to it's proper range (generally 185-195F or85-90C)
    b. Calibrate, repair or replace the temperature controller if necessary
    c. If electrically heated, check that the voltage, current, and resistance are correct
    d. If steam heated, check the steam supply, including solenoid, strainer and trap for proper operation
    e. Ensure that the temperature sensor is in the solution and not damaged or leaking
    f. Measure the temperature of the agitation air, and if necessary preheat the air

3. **Low pH**
    a. Measure the bath's pH with a calibrated pH meter and increase it to it's proper range (generally between 4.8 and 5.2 pH) with 50% ammonia or potassium carbonate
    b. Recalibrate the pH meter or check the accuracy of pH papers used
    c. Eliminate any sources of acid drag in, such as blind holes and poor rinsing
    d. Confirm that the proper ratio of hypophosphite to nickel replenisher is being used (for self pH regulating baths)

4. **Low nickel or reducer content**
    a. Analyze the bath's nickel and reducer content and increase them to their proper range
    b. Check the EDTA solution used for nickel titrations against a standard to ensure it's accuracy
    c. Ensure the only deionized water is used for nickel titrations
    d. Ensure that the plating tank's volume, used to determine replenishment amounts, is correct
    e. Ensure that the proper ratio of hypo to nickel replenishers has been used (generally either 1:1 or 2:1)

5. **Contaminated bath**
    a. Analyze the solution for poisonous metals (stabilizers) like lead, cadmium, bismuth and tin
    b. Dummy the solution by electroless methods or electrolytically at low current density and large cathode area to remove contaminates
    c. Carbon treat the solution by circulating it through carbon cartridges or a packed filter
    d. Dispose of the bath if b) or c) are not successful and make up a new one
    e. Identify and eliminate the source of contamination. Look for: Racks or barrels that have been used in incompatible processes like cadmium; contaminated rinses; drag in blind holes and pores; parts plated with poisonous metals; incompatible maskants; drainage from adjacent equipment; steam coil leaks; impurities in agitation air or process water

6. **Bath loading to low**
    a. Check that bath loading is above 0.25 ft2/gal or 0.6 dm2/l (for some heavy metal stabilized baths)
    b. Put dummy panels into the bath to raise the loading to about 0.4 ft2/gal or 1 dm2/L
    c. Increase the number of parts in the bath to obtain about 0.4 ft2/gal or 1 dm2/L

7. **Incorrect bath replenishment (too much stabilizer)**
    a. Confirm that the proper ratio of hypophosphite to nickel replenisher is being used
    b. If possible, discard part of the bath and adjust with replenisher to bring the solution into balance
    c. If not, dispose of the bath and make up a new one

8. **Too much air agitation**
    a. Reduce air to the minimum required for solution movement (for some heavy metal stabilized baths)

9. **Excessive bath age**
    a. Check bath records or analize the bath for orthophosphate to determine the bath's age
    b. Depending on formulation, bath's typically slow down as they get older
    c. If older than normal range for bath (often equals 1 or 2 mol/L of ortho), dispose of the bath and make up a new one

10. **Improperly made up bath**
    a. Confirm that the bath was made up correctly. Adjust, if possible, or dispose of the bath

11. **Large parts are cooling the bath**
    a. Measure the bath's temperature before and after the parts are introduced to determine the amount of cooling
    b. Preheat the parts in the soak cleaner or heated rinse prior to placing them in the tank

12. **Improper substrate pretreatment**
    a. Confirm that the proper pretreatment has been used, especially for hard to activate alloy steels

13. **Processing large amounts of aluminum**
    a. Accumulation of zinc from zincated surfaces and organic acids will cause many baths to slow down
    b. Dummy the solution electrolessly with steel wool in to filter bag to remove zinc
    c. Dispose of the bath if b) is not successful and make up a new one
    d. Install an ammoniacal strike bath before the electroless nickel bath

14. **Putting nickel titration samples into the bath**
    a. The EDTA used to titrate the nickel solutions is a very strong chelator and will slow a bath
    b. Dispose of the titration samples in some other way
    c. Dispose of the bath and make up a new one

High Plating Rate

1. **Incorrect thickness measurement**
    a. Repeat the test, ensuring that test specimans are clean and dry
    b. Recalibrate the micrometer or thickness test instrument using standards of proper phosphorus content
    c. If necessary, confirm thickness microscopically on a cross section of the coating

2. **High temperature**
    a. Measure the bath's temperature with a calibrated thermometer and reduce it to its proper range (generally 185-195F or 85-90C)
    b. Calibrate, repair or replace the temperature controller if necessary
    c. If electrically heated, check that the voltage, current, and resistance are correct
    d. If steam heated, check the steam supply, including solenoid, strainer and trap for proper operation
    e. Ensure that the temperature sensor is in the solution and not damaged or leaking

3. **High pH**
    a. Measure the bath's pH with a calibrated pH meter and reduce it to its proper range (generally between 4.8 and 5.2 pH) with 50% sulfuric acid
    b. Recalibrate the pH meter or check the accuracy of pH papers used
    c. Eliminate any sources of alkaline drag in, such as blind holes and poor rinsing
    d. Check steam coils or heaters for leaks and repair or replace if necessary
    e. Confirm that the proper ratio of hypophosphite to nickel replenisher is being used (for self pH regulating baths)

4. **High nickel or reducer content**
    a. Analyze the bath's nickel and reducer content and reduce them to their proper range through dilution or continued plating
    b. Check the EDTA solution used for nickel titrations against a standard to ensure its accuracy
    c. Ensure that only deionized water is used for nickel titrations
    d. Ensure that the plating tank's volume, used to determine replenishment amounts, is correct

5. **Bath loading too high**
    a. Check that bath loading is below 0.75 ft2/gal or 1.9 dm2/L (for some heavy metal stabilized baths)
    b. Reduce the number of parts in the bath to obtain a bath loading less than 0.75 ft2/gal or 1.9 dm2/L
    c. Ensure that the tank is not plating out on the plating ot its components

6. **Improperly made up bath**
    a. Confirm that the bath was made up correctly. Adjust, if possible, or dispose of the Bath

7. **Incorrect bath replenishment**
    a. Confirm that the proper ratio of hypophosphite to nickel replenisher is being used
    b. If necessary, adjust with the needed replenisher to bring the solution into balance

Rapid pH Changes

1. **Incorrect pH measurement**
    a. Measure the bath's pH with a calibrated pH meter
    b. Recalibrate the pH meter or check the accuracy of pH papers used

2. **Drag-in of pretreatment chemicals**
    a. Eliminate any sources of pretreatment chemicals (acids and alkali) drag in, such as blind holes or high barrel loading
    b. Improve rinsing

3. **Bath loading too high**
    a. Check that bath loading is below 0.75ft2/gal or 1.9 dm2/L
    b. Reduce the number of parts in the bath to obtain a bath loading less than 0.75 ft2/gal or 1.9 dm2/L
    c. Install an automatic pH or bath controller to add neutralizer as it is needed
4. **Bath plating out on tank or components**
    a. Transfer the bath to another clean tank through a 1 micron filter bag
    b. Strip and passivate the tank and equipment with room temperature, 30% nitric acid

5. **Solution's pH is outside of its buffered range**
    a. Return the bath's pH to its proper range (generally between 4.8 and 5.2 pH) with 50% ammonia or potassium carbonate
    b. Add additional buffering agents to the bath (for some simple bath formulations)

6. High drag out losses (loss of buffers)
    a. Measure nickel concentration of rinse after the plating tank and calculate the amount of bath being lost
    b. Reduce drag out by draining or spray rinsing the parts over the plating tank before placing them in the rinse tank
    c. Add small amounts of make up concentrate (typically 1-2% per bath cycle) to replace the buffers being lost

Excessive Nickel Consumption

1. **Incorrect nickel analysis**
    a. Repeat the analysis using fresh reagents, ensuring that the procedure is carefully followed
    b. Check the EDTA solution used for nickel titrations against a standard to ensure its accuracy
    c. Ensure that only deionized water is used for nickel titrations

2. **Bath plating out on tank or components**
    a. Transfer the bath to another clean tank through a 1 micron filter bag
    b. Strip and passivate the tank and equipment with room temperature, 30% nitric acid

3. **High bath loading**
    a. Recalculate the surface area of the parts being plating, accounting for increased surface due to roughness, to confirm that nickel usage is not normal
    b. Check that bath loading is below 0.75 ft2/gal or 1.9 dm2/L
    c. Reduce the number of parts in the bath to obtain a bath loading less than 0.75 ft2/gal or 1.9 dm2/l

4. **High drag out losses**
    a. Measure nickel concentration of rinse after the plating tank and calculate the amount of nickel being lost
    b. Reduce drag out by draining or spray rinsing the parts over the plating tank before placing them in the rinse tank

5. **Higher plating rate than expected**
    a. Carefully measure the plating rate with properly prepared panels
    b. Reduce the plating time to obtain the proper thickness

6. **Bath decomposing**
    a. Observe solution for rapid gassing and the presence of dark gray or black particles
    b. Quickly cool the bath and transfer it to another clean tank through a 1 micron filter bag
    c. If the bath is still usable, add replenishers and neutralizers to return its concentration and pH to its normal operating range
    d. Dispose of the bath if c) is not successful and make up a new one

7. **Anodic passivation system operating at high current**
    a. Measure the current flow to the cathodes to confirm that the system is operating in its recommended range
    b. If the current is above normal (typically 1-2 amperes), reduce the voltage to the recommended range

8. **Leaks from the tank or its components**
    a. Inspect the tank, its piping, pumps, heaters and filters for drips and leaks
    b. Repair or replace leaking components

9. **Low strength nickel replenisher**
    a. Analyze the nickel replenisher or liquid nickel sulfate to confirm that its nickel concentration is normal
    b. If low, examine the bottom of the replenisher drum for crystals or precipitates
    c. If necessary, adjust the bath with additional replenisher to bring it into balance

Excessive Reducer Consumption

1. **Incorrect hypo analysis**
    a. Repeat the analysis using fresh reagents, ensuring that the procedure is carefully followed
    b. Check the iodine and thiosulfate solutions used for hypophosphite titrations against standards to ensure their accuracy
    c. Ensure that the sample stands in the dark for 30 minutes prior to the titration

2. **Standing idle at operating temperature**
    a. Keeping a bath at operating temperature without work increases reducer consumption
    b. Allow the bath to cool to a temperature below 150F (65C) when it is not in use
    c. Install a heat exchanger or coil to cool the bath rapidly after it is used

3. **Incorrect additions**
    a. Ensure that the plating tank's volume, used to determine replenishment amounts, is correct
    b. Ensure that the proper ratio of hypo to nickel replenishers has been used (generally either 1:1 or 2:1)

4. **Frozen reducer component**
    a. Check reducer component drum for solids and for stratification
    b. After heating to recommended temperature, stir the solution to re dissolve solids and make homogeneous
    c. Store reducer component drums at a temperature above that recommended by its manufacturer

5. **Low strength reducer replenisher**
    a. Analyze the reducer replenisher to confirm that its hypophosphite concentration is normal
    b. If low, examine the bottom of the replenisher drum for crystals or precipitates
    c. If necessary, adjust the bath with additional replenisher to bring it into balance

Decomposing Bath

1. **High temperature**
    a. Measure the bath's temperature with a calibrated thermometer and reduce it to its proper range (generally 185-195F or 85-90C)
    b. Calibrate, repair or replace the temperature controller if necessary
    c. If electrically heated, check that the voltage, current, and resistance are correct
    d. If steam heated, check the steam supply, including solenoid, strainer and trap for proper operation
    e. Ensure that the temperature sensor is in the solution and not damaged or leaking

2. **Localized overheating**
    a. Observe the solution for rapid gassing and the presence of particles around the heater
    b. Increase agitation around immersion heaters either with increased solution flow or air
    c. Move immersion heaters away from the tank wall to improve solution circulation
    d. Change to external pump through heat exchangers
    e. If electric, change to derated immersion heaters

3. **High pH**
    a. Observe solution for the presence of nickel hydroxide precipitates
    b. Measure the bath's pH with a calibrated pH meter and reduce it to its proper range (generally between 4.8 and 5.2 pH) with 50% sulfuric acid
    c. Recalibrate the pH meter or check the accuracy of pH papers used
    d. Check the neutralizer is not too concentrated (normally 50% ammonium hydroxide or potassium carbonate should be used)
    e. Eliminate any sources of alkaline drag in, such as blind holes and poor rinsing
    f. Check steam coils or heaters for leaks and repair or replace if necessary

4. **Excessive additions**
    a. Check bath records to ensure that additions larger than 10 or 15 percent are not being made
    b. Make smaller, more frequent additions
    c. Make certain that additions are made away from immersion heaters
    d. Install an automatic bath controller to make more frequent additions to keep the bath in balance

5. **Bath loading too high**
    a. Check that bath loading is below 0.75 ft2/gal or 1.9 dm2/L (for some heavy metal stabilized baths)
    b. Reduce the number of parts in the bath to obtain a bath loading less than 0.75 ft2/gal or 1.9 dm2/L

c. Ensure that the tank is not plating out on the plating or its components

6. **Drag in of catalyst like palladium**
   a. Analyze solution for the presence of palladium and tin
   b. Eliminate any sources of catalyst drag in, such as blind holes or high barrel loading
   c. Improve rinsing

7. **Inadequate stabilizer**
   a. Ensure that the proper ratio of hypo to nickel replenishers has been used (generally either 1:1 or 2:1)
   b. Where possible, analyze the solution for stabilizers like lead and cadmium
   c. If necessary, add additional stabilizers to bring the bath into balance

8. **Presence of particles**
   a. Locate and eliminate any external sources of particles, like blasting or grinding media
   b. Keep the tank covered when it is not in use
   c. Filter the solution through 1 micron bag filters at a rate to 10 tank volumes per hour
   d. Totally filter the solution while it is being transferred through a ½ or 1 micron filter

Excessive Plate Out

1. **Tank not passivated often enough**
   Transfer the bath through a ½ or 1 micron filter bag into a second tank every 1 to 3 days (period depends on bath formulation)

2. **Anodic passivation not properly set**
   a. Ensure that potentiostat and wiring are correct (tank must be anodic)
   b. Set potential to about 0.75 volt

3. **Stripping operation incomplete**
   a. Ensure that there is no nickel remaining on the tank or it's components after passivation
   b. Leave the nitric acid in the tank for a longer period

4. **Low strength nitric acid**
   a. Analyze the nitric acid solution for acidity (it should be at least 20%)
   b. If necessary, add more concentrated acid to increase the acidity to 30%

5. **Plating parts touching the tank**
   a. Rack the parts so that they do not contact the tank's walls or bottem

6. **Inadequate filtration**
   a. Filter the solution through 1 micron bag filters at a rate equal to 10 tank volumes per hour

7. **Insufficient agitation**
   a. Increase agitation (air) to ensure that the bath and replenishments are well mixed and that particles are suspended until they are filtered
   b. Ensure that the agitation pattern moves particles away from the parts and into the filters (bath should show a uniform, rolling motion)

8. **Particle drag in with parts**
    a. Improve pretreatment cycle to remove particles
    b. Inspect at the last rinse for water breaks

9. **Airborne particles falling into bath**
    a. Locate and eliminate any external sources of particles, like blasting or grinding media
    b. Keep the tank covered when it is not in use

10. **Dirty air supply**
    a. Check the quality of the agitation air by blowing it through a white cloth or bag filter
    b. Install a filter on the inlet to the air filter
    c. Install a filter/separator on the compressed air supply
    d. Install a regenerative blower with filter to supply the plating tank

11. **Inadequate stabilizer**
    a. Ensure that the proper ratio of hypo to nickel replenishers has been used (generally either 1:1 or 2:1)
    b. Where possible, analyze the solution for stabilizers like lead and cadmium
    c. If necessary, add additional stabilizers to bring the bath into balance

12. **Excessive additions**
    a. Check bath records to ensure that additions larger than 10 or 15 percent are not being made
    b. Make smaller, more frequent additions
    c. Make certain that additions are made away from immersion heaters and tank walls
    d. Install an automatic bath controller to make more frequent additions to keep the bath in balance

13. **Overetched liner or tank**
    a. Replace the liner or tank

14. **High pH**
    a. Measure the bath's pH and reduce it to its proper range (generally between 4.8 and 5.2 pH) with 50% sulfuric acid
    b. Recalibrate the pH meter or check the accuracy of pH papers used
    c. Eliminate any sources of alkaline drag in, such as blind holes and poor rinsing
    d. Check steam coils or heaters for leaks and repair or replace if necessary
    e. Confirm that the proper ratio of hypophosphite to nickel replenisher is being used (for self pH regulating baths)

15. **Localized overheating**
    a. Observe solution for rapid gassing and the presence of particles around the heater
    b. Increase agitation around immersion heaters either with increased solution flow or air
    c. Move immersion heaters away from the tank wall to improve solution circulation
    d. Change to external pump through heat exchangers
    e. If electric, change to derated immersion heaters

16. **Incorrect tank material**
    a. Pigmented polypropylene or CPVC tank liners should not be used (replace with natural polypropylene)
    b. Cloudy Bath (White out)

White-Out

1. **High pH**
    a. Measure the bath's pH with a calibrated pH meter
    b. If the pH is above its normal range, lower it until the solution clears with 50% sulfuric or acetic acid, and then increase it to the proper range (generally between 4.8 and 5.2 pH) with 50% ammonia or potassium carbonate
    c. Recalibrate the pH meter or check the accuracy of pH papers used
    d. Confirm that the proper ratio of hypophosphite to nickel replenisher is being used (for self pH regulating baths)

2. **Excessive bath age**
    a. Check bath records or analyze the bath for orthophosphate to determine the bath's age
    b. If older than normal range for bath (often equals 1 or 2 mo/L of ortho), dispose of the bath and make up a new one
    c. Add 1% by volume glycolic or lactic acid to clear the solution and then increase the bath's pH to it proper range with 50% ammonia or potassium carbonate

3. **High drag out losses (loss of complexers)**
    a. Measure nickel concentration of rinse after the plating tank and calculate the amount of bath being lost
    b. Reduce drag out by draining or spray rinsing the parts over the plating tank before placing them in the rinse tank
    c. Add small amounts of make up concentrate (typically 1-2% per bath cycle) to replace the complexor being lost

4. **Over replenishment of hypo component**
    a. Analyze the bath's reducer content to determine if it is greatly above its normal range
    b. If it is high, reduce it to its proper range through dilution or continued plating
    c. Confirm that the proper ratio of hypophosphite to nickel replenisher is being used

5. **Very high nickel content**
    a. Analyze the bath's nickel content (very high nickel concentrations may cause some baths to become cloudy)
    b. Discard enough of the bath to return its nickel content to normal and add an equivalent amount of make up concentrate (complexer)
    c. Check the EDTA solution used for nickel titrations against a standard to ensure its accuracy
    d. Confirm that the proper ratio of nickel to hypophosphite replenisher is being used
    e. Ensure that the plating tank's volume, used to determine replenishment amounts, is correct

6. **Contamination**
    a. Use only deionized water to make up and maintain the bath (tap water contains calcium and magnesium which can precipitate)
    b. Eliminate any sources of alkaline drag in, such as blind holes and poor rinsing
    c. Check steam coils or heaters for leaks and repair or replace if necessary
    d. Eliminate any drainage from adjacent equipment

7. **Excessive build up or drag in of iron, aluminum or zinc**
    a. Analyze the solution for metals like iron, aluminum and zinc that tie up the bath's complexers
    b. Improve rinsing before plating to minimize drag in

c. Dummy the solution electrolessly with steel wool in to filter bag to remove zinc
d. Dispose of the bath if c) is not successful and make up a new one

8. **Replenishments made to quickly**
   a. Add replenishers to the bath slowly and in an area with good agitation

Poor Adhesion (ferrous alloys)

1. **Improper adhesian test**
   a. Test according to ASTM B-733 or AMS 2404 using specimens of the alloy being processed

2. **Improper cleaning and activation**
   a. Confirm that the pretreatment procedure is correct for the alloy being processed
   b. Confirm that the substrate is the alloy specified (by customer records or analysis or spot tests)

3. **Inadequate cleaning**
   a. After acid activation, examine parts for water breaks, and if present, reprocess through pretreatment cycle
   b. Measure the cleaner's temperature with a calibrated thermometer and if necessary adjust it to its proper range
   c. Check cleaner records to determine the solution's age
   d. If older than normal (generally when more than 200 ft2/gal has been processed), dispose of the cleaner and make up a new one
   e. Analyze the solution for alkalinity
   f. If alkalinity is lower than normal, add cleaner or dispose of the solution and make up a new one
   g. Observe the cleaner for the presence of an oil film on its surface
   h. If oil is visible, dispose of the cleaner and make up a new solution

4. **Inadequate activation**
   a. After all pretreatment steps, wipe surface with white cloth or cotton swab to detect smut, and if present, improve cycle to remove it
   b. Observe the acid for color and for uniform gassing of the steel (iron buildup)
   c. If dark yellow and steel does not gas uniformly, dispose of the acid and make up a new solution
   d. Check the part after activation for a copper bloom (immersion copper deposit), and if present, dispose of the acid and make up a new solution
   e. Analyze the solution for acidity
   f. If acidity is lower than normal, add acid or dispose of the solution and make up a new one
   g. Observe the acid for the presence of an oil film on its surface
   h. If oil is visible, dispose of the acid, carefully clean the tank and make up a new solution

5. **Contaminated rinse water**
   a. Observe that the rinses are clear and free flowing
   b. If rinses are not, increase the water flow rate
   c. Observe the rinse water for the presence of an oil film on its surface or tank walls
   d. If oil is visible, drain and carefully clean the tank and refill it with clean water
   e. Increase the air agitation rate in the rinse water

6. **Insoluble oils or soils on substrate**
    a. Check that cleaners will remove (dissolve) the machining or cutting oils
    b. If cleaner cannot remove them, change to a different type of oils or a different cleaner

7. **Drag in of acid inhibitors**
    a. Improve rinsing
    b. Do not use inhibiters or wetting agents in activating acids

8. **Excessive time in the final rinse**
    a. After rinsing, wipe the surface with white cloth or cotton swab to detect rust, and if present, rinse the parts more quickly

9. **Unknown passive alloy steel**
    a. Determine the alloy of the substrate (by customer records or analysis or spot tests)
    b. Observe the part while it is in the activation acid to see if it gasses uniformly
    c. Try using a nickel strike or higher strength or higher temperature acid
    d. If no smut develops and gassing occurs, plate after a quick rinse

10. **Plating high alloy steels without a strike**
    a. Determine the alloy of the substrate (by customer records or analysis or spot tests)
    b. Use a Woods or sulfamate nickel strike before plating

11. **Plating high carbon alloys (like cast iron)**
    a. After pretreatment, wipe surface with white cloth or cotton swab to detect smut
    b. Reduce immersion time in acids and electroclean after activation
    c. Add a dispersion agent to the acid at low concentration (requires a subsequent electrocleaning and good rinsing)

12. **Contaminated electroless nickel bath**
    a. Analyze the solution for copper which can cause immersion deposits on steel and cause poor adhesion
    b. Dummy the solution by electroless methods or electrolytically at low current density and large cathode area to remove copper
    c. Carbon treat the solution by circulating it through carbon cartridges or a packed filter
    d. Dispose of the bath if b) or c) are not successful and make up a new one
    e. Identify and eliminate the source of contamination. Look for: Racks or barrels that have been used for copper; contaminated rinses; drag in blind holes or pores; copper alloy substrates not properly activated; incompatible maskants; drainage from work bars or adjacent equipment; steam coil leaks; impurities in agitation air or process water

13. **Inadequate heat treatment**
    a. Confirm that the heat treatment cycle is correct for the alloy being processed
    b. Heat treat (bake) the part according to ASTM B-733 or AMS 2404

Poor Adhesion (aluminum alloys)

1. **Improper adhesion test**

    a. Test according to ASTM B-733 or AMS 2404 using specimens of the alloy being processed

2. **Improper cleaning and activation**
    a. Confirm that the pretreatment procedure is correct for the alloy being processed
    b. Confirm that the substrate is the alloy specified (by customer records or analysis or spot tests)

3. **Inadequate cleaning**
    a. After desmutting, examine parts for water breaks (wrought alloys), and if present, reprocess through pretreatment cycle, being careful to avoid over etching the surface
    b. Measure the cleaner's temperature with a calibrated thermometer and if necessary adjust it to its proper range
    c. Check cleaner records to determine the solution's age
    d. If older than normal, dispose of the cleaner and make up a new one
    e. Analyze the solution for alkalinity
    f. If alkalinity is lower than normal, add cleaner or dispose of the solution and make up a new one
    g. Measure the specific gravity of the etch cleaner
    h. If higher than normal (often 1.25), dispose of the solution and make up a new one
    i. Observe the cleaner for the presence of an oil film on its surface
    j. If oil is visible, dispose of the cleaner and make up a new solution

4. **Inadequate activation**
    a. After desmutting, surface should be clean and white and free of smut, and if not, reprocess through pretreatment cycle, being careful to avoid over etching the surface
    b. Observe the desmutting acid for gassing of the aluminum
    c. If it does not gas vigorously and then stop, dispose of the acid and make up a new solution
    d. Analyze the solution for acidity
    e. If acidity is lower than normal, add acid or dispose of the solution and make up a new one
    f. Observe the acid for the presence of an oil film on its surface
    g. If oil is visable, dispose of the acid, carefully clean the tank and make up a new solution

5. **Inadequate zincating**
    a. After zincating, surface should be coated with a thin uniform or mottled gray deposit, and if not, reprocess through pretreatment cycle
    b. Use the double zincate process
    c. Use dilute, alloy zincate solution developed for electroless nickel plating
    d. Observe the zincate solution for gassing of the aluminum
    e. If the aluminum gasses rapid, the solution is deplete
    f. If depleted, add zincate or dispose of the solution and make up a new one
    g. Analyze the solution for zinc content
    h. If the zinc content is lower than normal, add zincate or dispose of the solution and make up a new one

6. **Contaminated rinse water**
    a. Observe that the rinses are clear and free flowing
    b. If rinses are not, increase the water flow rate
    c. Observe the rinse water for the presence of an oil film on its surface or tank walls
    d. If oil is visible, drain and carefully clean the tank and refill it with clean water
    e. Increase the air agitation rate in the rinse water

7. **Reoxidation of surface**
    a. Reduce transfer time between process steps, and especially between the last zincate rinse and plating

b. Reduce rinsing time (generally should not exceed 1 minute)

8. **Insoluble oils or soils on substrate**
   a. Check that cleaners will remove (dissolve) the matching or cutting oils
   b. If cleaner cannot remove them, change to a different type of oils or a different cleaner

9. **Drag in of acid inhibitors**
   a. Improve rinsing
   b. Do not use inhibitors or wetting agents in activating acids
   c.

10. **Excessive bath age**
    a. Accumulation of zinc from zincated surfaces and organic acids in many baths will reduce adhesion
    b. If the bath is older than normal, dispose of it and make up a new one
    c. Use potassium carbonate instead of ammonia to neutralize baths used primarily with aluminum
    d. Install an ammoniacal strike bath before the electroless nickel bath

11. **Contaminated electroless nickel bath**
    a. Carbon treat the solution by circulating it through carbon cartridges or a packed filter
    b. Dispose of the bath if treatment is not successful and make up a new one
    c. Identify and eliminate the source of contamination. Look for: Racks or barrels that have been used for incompatible processes; contaminated rinses: drag in blind holes or pores; incompatible maskants; drainage from adjacent equipment; steam coil leaks; impurities in agitation air or process water

12. **Inadequate heat treatment**
    a. Confirm that the heat treatment cycle is correct for the alloy being processed
    b. Heat treat (bake) the part according to ASTM B-733 or AMS 2404

Poor Adhesion (copper alloys)

1. **Improper adhesian test**
   a. Test according to ASTM B-733 or AMS 2404 using specimans of the alloy being processed

2. **Improper cleaning and activation**
   a. Confirm that the pretreatment procedure is correct for the alloy being processed
   b. Confirm that the substrate is the alloy specified (by customer records or analysis or spot tests

3. **Inadequate cleaning**
   a. After acid activation, examine parts for water breaks, and if present, reprocess through pretreatment cycle
   b. Measure the cleaner's temperature with a calibrated thermometer and if necessary adjust it to its proper range
   c. Check cleaner records to determine the solutions age
   d. If older than normal (generally when more than 200 ft2/gal has been processed), dispose of the cleaner and make up a new one
   e. Analyze the solution for alkalinity

f. If alkalinity is lower than normal, add cleaner or dispose of the solution and make up a new one
g. Observe the cleaner for the presence of an oil film on its surface
h. If oil is visible, dispose of the cleaner and make up a new solution

4. **Inadequate activation**
   a. After all pretreatment steps, wipe surface with white cloth or cotton swab to detect smut, and if present, improve cycle to remove it
   b. After activation, observe the part's surface for a uniform yellow color, and if not present reprocess through pretreatment cycle
   c. If leaded alloy, ensure that activation includes immersion in fluoroboric or sulfamate acid to remove lead smears
   d. Analyze the solution for acidity
   e. If acidity is lower than normal, add acid or dispose of the solution and make up a new one
   f. Observe the acid for the presence of an oil film on its surface
   g. If oil is visible, dispose of the acid, carefully clean the tank and make up a new solution

5. **Inadequate or slow initiation**
   a. Copper alloys are not catalytic to electroless nickel deposition and will not initiate plating by themselves
   b. Ensure that the copper begins plating quickly after the parts are placed into the bath
   c. Initiate plating with an electrolytic strike in the electroless nickel solution, or Woods nickel strike prior to plating
   d. Install an ammoniacal, hypophosphite predip solution prior to plating
   e. Avoid galvanic initiation of the copper by contacting the parts with steel
   f. Avoid using palladium catalyst solutions to initiate plating

6. **Contaminated rinse water**
   a. Observe that the rinses are clear and free flowing
   b. If rinses are not, increase the water flow rate
   c. Observe the rinse water for the presence of an oil film on its surface or tank walls
   d. If oil is visible, drain and carefully clean the tank and refill it with clean water
   e. Increase the air agitation rate in the rinse water

7. **Insoluble oils or soils on substrate**
   a. Check that cleaners will remove (dissolve) the machining or cutting oils
   b. If cleaner cannot remove them, change to a different type of oils or a different cleaner

8. **Drag in of acid inhibitors**
   a. Improve rinsing
   b. Do not use inhibitors or wetting agents in activating acids

9. **Contaminated electroless nickel bath**
   a. Carbon treat the solution by circulating it through carbon cartridges or a packed filter
   b. Dispose of the bath if treatment is not successful and make up a new one
   c. Identify and eliminate the source of contamination. Look for: Racks or barrels that have been used for incompatible processes; contaminated rinses: drag in blind holes or pores; incompatible maskants; drainage from adjacent equipment; steam coil leaks; impurities in agitation air or process water

10. **Inadequate heat treatment**
    a. Confirm that the heat treatment cycle is correct for the alloy being processed
    b. Heat treat (bake) the part according to ASTM B-733 or AMS 2404

Rough Deposit

1. **Inadequate filtration**
   a. Filter the solution through 1 micron bag filters at a rate equal to 10 tank volumes per hour
   b. Totally filter the solution while it is being transferred through a ½ or 1 micron filter

2. **Insufficient agitation**
   a. Increase agitation (air) to ensure that the bath and replenishments are well mixed and that particles are suspended until they are filtered
   b. Ensure that the agitation pattern moves particles away from the parts and into the filters (bath should show a uniform, rolling motion)

3. **Contamination (dirty atmosphere)**
   a. Locate and eliminate any external sources of particles, like blasting or grinding media
   b. Keep the tank covered when it is not in use

4. **Shelf roughness**
   a. Place parts in the rack so that critical surfaces are not facing upwards
   b. Change the angle of the parts occasionally during plating so that the shelf is spread over the entire surface
   c. Provide auxiliary agitation across the shelf area

5. **Bath plating out on tank or components**
   a. Check the tank and its components for evidence of plate out
   b. Transfer the bath to another clean tank through a 1 micron filter bag
   c. Strip and passivate the tank and equipment with room temperature, 30% nitric acid

6. **Inadequate passivation of tank**
   a. Ensure that there is no nickel remaining on the tank or its components after passivation
   b. Leave the nitric acid in the tank for a longer period to complete stripping

7. **Overactive plating solution**
   a. Check that the bath's temperature, pH and concentration are with in the proper range
   b. If necessary, adjust the temperature, pH or concentration to their proper range
   c. Reduce the solution's plating rate

8. **Contaminated water**
   a. Use only deionized water to make up and maintain the bath (tap water contains calcium and magnesium which can precipitate)
   b. Improve filtration and carbon treatment in the deionized water system
9. **Localized overheating**
   a. Observe solution for rapid gassing and the presence of particles around the heater
   b. Increase agitation around immersion heaters either with increased solution flow or air
   c. Move immersion heaters away from the tank wall to improve solution circulation
   d. Change to external pump through heat exchangers
   e. If electric, change to derated immersion heaters

10. **Excessive bath age**
    a. Check bath records or analyze the bath for orthophosphate to determine the bath's age
    b. If older than normal range for bath (often equals 1 or 2 mol/L of ortho), dispose of the bath and make up a new one

c. If cloudy, add 1% by volume glycolic or lactic acid to clear the solution and then increase the bath's pH to its proper range with 50% ammonia or potassium carbonate

11. **Inadequate stabilizer**
    a. Ensure that the proper ratio of hypo to nickel replenishers has been used (generally either 1:1 or 2:1)
    b. Where possible, analyze the solution for stabilizers like lead and cadmium
    c. If necessary, add additional stabilizers to bring the bath into balance

12. **Residual magnetism**
    a. Check the parts (iron or nickel based) with a gauss meter (magnetic field indicator) to detect residual magnetism
    b. Values as low as 5 or 10 gauss will often times cause roughness
    c. Demagnetize the parts prior to pretreatment and plating

13. **Stray currents**
    a. Find and eliminate any sources of stray current
    b. Properly ground all equipment
    c. Check that the anodic passivation system is properly connected and set up

14. **Replenishments made too quickly**
    a. Add replenishment solutions to the bath slowly and in a well agitated location
    b. Add the nickel and hypophosphite solutions separately
    c. Add replenishment solutions into the bag filter or the circulation pump overflow opening

15. **Replenishments made over parts or heater**
    a. Make additions in a well agitated location away from the parts and heater

16. **Bath loading too high**
    a. Check that bath loading is below 0.75ft2/gal or 1.9 dm2/L (for some heavy metal stabilized baths)
    b. Reduce the number of parts in the bath to obtain a bath loading less than 0.75 ft2/gal or 1.9 dm2/L
    c. Ensure that the tank is not plating out on the plating or its components

17. **Improper pretreatment**
    a. Confirm that the appropriate pretreatment procedure has been used
    b. After the activation, examine parts for water breaks, and if present, reprocess and improve pretreatment cycle
    c. Ensure that the pretreatment procedure is not etching the parts

18. **Inadequate rinsing**
    a. Observe that the rinses are clear and free flowing
    b. If rinses are not, increase the water flow rate
    c. Do not rinse parts after alkali cleaning and acid activation in the same rinse water

19. **Particle drag in with parts**
    a. Improve pretreatment cycle to remove particles
    b. Inspect at the last rinse for water breaks
    c. Avoid the use of glass beads for abrasive blasting; aluminum oxide is preferred

20. **Cleaner drag in**
    a. Eliminate any sources of alkaline drag in, such as blind holes and poor rinsing
    b. Improve rinsing

21. **Part out gassing**
    a. Check castings or powder metal parts for porosity that can spit out soils
    b. Use alternating hot and cold rinses to pump soils out of the pores
    c. Bake the parts at 400F (200C) or more for 1 hour prior to pretreatment

22. **Dirty air supply**
    a. Check the quality of the agitation air by blowing it through a white cloth or bag filter
    b. Install a filter on the inlet to the air filter
    c. Install a filter/separator on the compressed air supply
    d. Install a regenerative blower with filter to supply the plating tank

23. **Incorrect tank material**
    a. Pigmented polypropylene or CPVC tank liners should not be used (replace with natural polypropylene)

24. **Contaminated filters or liners**
    a. Filters and liners should be leached or rinsed completely prior to use

25. **Steam leaks**
    a. Check steam coils or heaters for leaks and repair or replace if necessary

Laminated Deposit

1. **Wide swings in bath temperature**
    a. Maintain the bath's temperature in its proper range (generally 185-195F or 85-90C)
    b. Calibrate, repair or replace the temperature controller if necessary
    c. If electrically heated, check the voltage, current, and resistance are correct
    d. If steam heated, check the steam supply, including solenoid, strainer and trap for proper operation
    e. Ensure that the temperature sensor is in the solution and not damaged or leaking
    f. If large loads are causing the bath's temperature to drop abnormally, reduce the load or preheat it

2. **Wide swings in the bath pH**
    a. Maintain the bath's pH in its proper range (generally between 4.8 and 5.2 pH)
    b. Recalibrate the pH meter or check the accuracy of pH papers used
    c. Eliminate any sources of acid or alkali drag in, such as blind holes and poor rinsing
    d. Install an automatic controller to make more frequent additions to keep the pH in proper range

3. **Wide swings in bath concentration**
    a. Maintain the bath's nickel and reducer content in their proper range
    b. Check the EDTA solution used for nickel titrations against a standard to ensure ita accuracy
    c. Ensure that only deionized water is being used for nickel titrations
    d. Ensure that the plating tank's volume, used to determine replenishment amounts, is correct
    e. Install an automatic bath controller to make more frequent additions to keep the bath in balance

4. **Replenishments made over parts**
    a. Make additions in a well agitated location away from the parts

5. **Parts removed from solution during plating**
    a. Parts must always remain in the solution during plating
    b. Use panels or razor blades to inspect the coating while plating

Non Uniform Deposit (Skip plating, edge pull back, etc.)

1. **Metallic contamination**
    a. Analyze the solution for heavy metals like lead, cadmium, bismuth and tin
    b. Dummy the solution by electroless methods or electrolytically at low current density and large cathode area to remove contaminates
    c. Dispose of the bath if b) is not successful and make up a new one
    d. Identify and eliminate the source of contamination. Look for: Racks or barrels that have been used in incompatible processes like cadmium; contaminated rinses; drag in blind holes or pores; parts plated with poisonous metals; drainage from adjacent equipment; impurities in process water

2. **Organic contamination**
    a. Check that organic maskants are properly cured and compatible with electroless nickel solutions
    b. Identify and eliminate other sources of contamination, such as from the air supply, drainage from overhead equipment, ethylene glycol, plastic components, and drag in of inhibitors or wetting agents
    c. Check steam coils or heaters for leaks and repair or replace if necessary
    d. Carbon treat the solution by circulating it through carbon cartridges or a packed filter
    e. Dispose of the bath if d) is not successful and make up a new one

3. **Improper treatment**
    a. Confirm that the appropriate pretreatment procedure has been used, especially for leaded and sulfurized alloys
    b. After acid activation, examine parts for water breaks, and if present, reprocess and improve pretreatment cycle
    c. Check that cleaners will remove (dissolve) the machining or cutting oils
    d. If cleaner cannot remove them, change to a different type of oils or a different cleaner
    e. Do not use inhibitors or wetting agents in activating acids

4. **Contaminated rinse water**
    a. Observe that the rinses are clear and free flowing
    b. If rinses are not, increase the water flow rate
    c. Observe the rinse water for the presence of an oil film on its surface or tank walls
    d. If oil is visible, drain and carefully clean the tank and refill it with clean water
    e. Increase the air agitation rate in the rinse water

5. **Excessive agitation**
    a. Reduce air to the minimum required for solution movement (for some heavy metal stabilized baths)

6. **Bath loading too low**
    a. Check that bath loading is above 0.25 ft2/gal or 0.6 dm2/L (for some heavy metal stabilized baths)
    b. Put dummy panels into the bath to raise the loading to about 0.4 ft2/gal or 1dm2/L
    c. Increase the number of parts in the bath to obtain about 0.4 ft2/gal or 1 dm2/L

7. **Parts clinging together**
    a. Inspect parts in barrels and baskets for freedom of movement
    b. Reduce the number of parts in the basket or barrel
    c. Add parts to the barrel or basket that will allow them to mix together better
    d. Increase or decrease the barrel's rotation speed
    e. Agitate basket mechanically

8. **Stray currents**
    a. Find and eliminate any sources of stray current
    b. Properly ground all equipment
    c. Check that the anodic passivation system is properly connected and set up

9. **Substrate contains more than one metal**
    a. Example parts for areas of passive metals (like stainless steel) such as inserts or repairs
    b. Consult with manufacturer for manufacturing or repair history
    c. If present, prepare the parts as if it all were passive metal (such as with strike)

Streaked, Patterned or Frosted Deposit

1. **Insufficient agitation**
    a. Increase agitation (air) to ensure that the bath is well mixed and that fresh solution is continuously supplied to the part's surface

2. **Gas patterns**
    a. Reposition the parts so that gas streaks do not occur
    b. Increase agitation, either with air or solution sparging or with a mechanical agitator
    c. Periodically, move the parts to a new location

3. **Improper pretreatment**
    a. Confirm that the appropriate pretreatment procedure has been used
    b. After cleaning, examine parts for patterns, and if present, reprocess and improve pretreatment cycle
    c. Ensure that the pretreatment procedure is not etching the parts

4. **Inadequate rinsing before plating**
    a. Observe that the rinses are clear and free flowing
    b. If rinses are not, increase the water flow rate
    c. Do not rinse parts after alkali cleaning and acid activation in the same rinse water
    d.
5. **Inadequate rinsing before plating**
    a. Observe that the rinse is clear and free flowing
    b. If rinse is not, increase the water flow rate
    c. Install a hot deionized rinse after plating

6. **Silicate drag in**
    a. Improve rinsing
    b. Use non-silicated cleaners

7. **Solution impingement**
    a. Solution from filters or solution sparger should not impinge on the parts
    b. Relocate the parts so that solution does not directly strike them
    c. Check the filters and spargers for particles

8. **Too much air agitation**
    a. Copious quantities of air should not impinge on the parts
    b. Relocate the parts so that the air does not directly strike them
    c. Reduce air to the minimum required for solution movement

9. **Metallic contamination**
    a. Analyze the solution for heavy metals like lead, bismuth, antimony and tin
    b. Dummy the solution by electroless methods or electrolytically at low current density and large cathode area to remove contaminates
    c. Dispose of the bath if b) is not successful and make up a new one
    d. Identify and eliminate the source of contamination. Look for: Racks or barrels that have been used in incompatible processes like cadmium; contaminated rinses; drag in blind holes or pores; parts plated with poisonous metals; drainage from adjacent equipment; impurities in process water

10. **Organic contamination**
    a. Check that organic maskants are properly cured and compatible with electroless nickel solutions
    b. Identify and eliminate other sources of contamination, such as from the air supply, drainage from overhead equipment, ethylene glycol, plastic components, and drag in of inhibitors or wetting agents
    c. Check steam coils or heaters for leaks and repair or replace if necessary
    d. Carbon treat the solution by circulating it through carbon cartridges or a packed filter
    e. Dispose of the bath if d) is not successful and make up a new one

11. **Bath loading too low**
    a. Check that bath loading is above 0.25 ft2/gal or 0.6 dm2/L (for some heavy metal stabilized baths)
    b. Put dummy panels into the bath to raise the loading to about 0.4 ft2/gal or 1dm2/L
    c. Increase the number of parts in the bath to obtain about 0.4 ft2/gal or 1dm 2/L

12. **Low reducer content**
    a. Analyze the bath's reducer content and increase it to its proper range
    b. Ensure that the plating tank's volume, used to determine replenishment amounts, is correct
    c. Ensure that the proper ratio of hypo to nickel replenishers has been used (generally either 1:1 or 2:1)

13. **Excessive bath age**
    a. Check bath records or analyze the bath for orthophosphate to determine the bath's age
    b. If older than normal range for bath (often equals 1 or 2 molL of ortho), dispose of the bath and make up a new one

Dull or Dark Deposit

1. **Improper pretreatment**
    a. Confirm that the appropriate pretreatment procedure has been used
    b. After cleaning, examine parts for patterns, and if present, reprocess and improve pretreatment cycle
    c. Ensure that the pretreatment procedure is not etching the parts

2. **Inadequate rinsing before plating**
    a. Observe that the rinses are clear and free flowing
    b. If rinses are not, increase the water flow rate
    c. Do not rinse parts after alkali cleaning and acid activation in the same rinse water

3. **Inadequate rinsing after plating**
    a. Observe that the rinse is clear and free flowing
    b. If rinse is not, increase the water flow rate
    c. Install a hot deionized rinse after plating

4. **Organic contamination**
    a. Identify and eliminate other sources of contamination, such as from the air supply, drainage from overhead equipment, ethylene glycol, plastic components, and drag in of inhibitors or wetting agents
    b. Carbon treat the solution by circulating it through carbon cartridges or a packed filter
    c. Dispose of the bath if b) is not successful and make up a new one

5. **Excessive bath age**
    a. Check bath records or analyze the bath for orthophosphate to determine the bath's age
    b. If older than normal range for bath (often equals 1 or 2 mol/L of ortho), dispose of the bath and make up a new one

6. **Bath loading too high**
    a. Check that bath loading is below 0.75 ft2/gal or 1.9 dm2/L
    b. Reduce the number of parts in the bath to obtain a bath loading less than 0.75 ft2/gal or 1.9 dm2/L
    c. Ensure that the tank is not plating out on the plating or its components

7. **High pH**
    a. Measure the bath's pH with a calibrated pH meter and reduce it to its proper range (generally between 4.8 and 5.2 pH) with 50% sulfuric acid
    b. Recalibrate the pH meter or check the accuracy of pH papers used
    c. Eliminate any sources of alkaline drag in, such as blind holes and poor rinsing
    d. Check steam coils or heaters for leaks and repair or replace if necessary
    e. Confirm that the proper ratio of hypophosphite to nickel replenisher is being used (for self pH regulating baths)

8. **Reducer and nickel imbalance**
    a. Analyze the bath's nickel and reducer content and adjust them to their proper range through dilution or additions
    b. Check the EDTA solution used for nickel titrations against a standard to ensure its accuracy
    c. Ensure that only deionized water is used for nickel titrations
    d. Ensure that the plating tank's volume, used to determine replenishment amounts, is correct

e. Ensure that the proper ratio of hypo to nickel replenishers has been used (generally either 1:1 or 2:1)

9. **Low nickel content**
    a. Analyze the bath's nickel content and increase it to its proper range
    b. Check the EDTA solution used for nickel titrations against a standard to ensure its accuracy
    c. Ensure that only deionized water is used for nickel titrations
    d. Ensure that the plating tank's volume, used to determine replenishment amounts, is correct
    e. Ensure that the proper ratio of hypo to nickel replenishers has been used (generally either 1:1 or 2:1)

10. **Low temperature**
    a. Measure the bath's temperature with a calibrated thermometer and increase it to its proper range (generally 185-195F or85-90C)
    b. Calibrate, repair or replace the temperature controller if necessary
    c. If electrically heated, check that the voltage, current, and resistance are correct
    d. If steam heated, check the steam supply, including solenoid, strainer and trap for proper operation
    e. Ensure that the temperature sensor is in the solution and not damaged or leaking
    f. Measure the temperature of the agitation air, and if necessary preheat the air

11. **Excessive brightner drag out**
    a. Ensure that the proper ratio of hypo to nickel replenishers has been used (generally either 1:1 or 2:1)
    b. Where possible, analyze the solution for brighteners like cadmium
    c. If necessary, add additional brighteners to bring the bath into balance

12. **Low reducer content**
    a. Analyze the bath's reducer content and increase it to its proper range
    b. Ensure that the plating tank's volume, used to determine replenishment amounts, is correct
    c. Ensure that the proper ratio of hypo to nickel replenishers has been used (generally either 1:1 or 2:1)

13. **Poor quality substrate**
    a. Example the appearance of the parts prior to plating for etching, roughness and uniformity
    b. Consult with manufacturer to see if their appearance can be improved

14. **Bath loading too low**
    a. Check that bath loading is above 0.25 ft2/gal or 0.6 dm2/L
    b. Put dummy panels into the bath to raise the loading to about 0.4 ft2/gal or 1dm2/L
    c. Increase the number of parts in the bath to obtain about 0.4 ft2/gal or 1dm2/L

15. **Excessive heat treatment temperature**
    a. Heat treatment at temperatures greater than 450 or 500F (230 or 260C) will cause the deposit to oxidize and discolor

16. **Metallic contamination**
    a. Analyze the solution for heavy metals like bismuth, antimony and tin
    b. Dummy the solution by electroless methods or electrolytically at low current density and large cathode area to remove contaminants
    c. Dispose of the bath if b) is not successful and make up a new one

d. Identify and eliminate the source of contamination. Look for: Racks or barrels that have been used in incompatible processes like cadmium; contaminated rinses; drag in blind holes or pores; parts plated with poisonous metals; drainage from adjacent equipment; impurities in process water

Porous Deposit (Pitting)

1. **Organic contamination**
   a. Check that organic maskants are properly cured and compatible with electroless nickel solutions
   b. Identify and eliminate other sources of contamination, such as from the air supply, drainage from overhead equipment, ethylene glycol, plastic components, and drag in of inhibitors or wetting agents
   c. Check steam coils or heaters for leaks and repair or replace if necessary
   d. Carbon treat the solution by circulating it through carbon cartridges or a packed filter
   e. Dispose of the bath if d) is not successful and make up a new one

2. **Insufficient agitation**
   a. Increase agitation (air) to ensure that the bath and replenishments are well mixed and that particles are suspended until they are filtered
   b. Ensure that the agitation pattern moves particles away from the parts and into the filters (bath should show a uniform, rolling motion)

3. **Poor quality substrate (castings)**
   a. Check castings or powder metal parts for porosity that can produce pits
   b. Minimize excessive cleaning that can open up porosity
   c. Improve agitation in the electroless solution
   d. Use alternating hot and cold rinses to pump soils out of the pores
   e. Bake the parts at 400F (200C) or more for 1 hour prior to pretreatment
   f. Organic impregnation (Loctite) or electrolytic strikes can sometimes seal porosity

4. **Hydrogen evolution**
   a. Observe solution for evidence of rapid evolution of hydrogen (gassing) around the parts, heater, or tank
   b. If tank is plating, transfer the bath to another clean tank through a 1 micron filter bag
   c. Measure the bath's pH and if necessary reduce it to its proper range with 50% sulfuric acid
   d. Check that bath loading is below 0.75 ft2/gal or 1.9 dm2/L, and if not reduce the number of parts to obtain the proper loading
   e. Analyze the bath's reducer content and if necessary reduce it to its proper range

5. **Presence of particles**
   a. Locate and eliminate any external sources of particles, like blasting or grinding media
   b. Keep tank covered when it is not in use
   c. Filter the solution through 1 micron bag filters at a rate equal to 10 tank volumes per hour
   d. Totally filter the solution while it is being transferred through a ½ or 1 micron filter
   e. Avoid the use of glass beads for abrasive blasting; aluminum oxide is preferred

6. **Metallic contamination**
   a. Analyze the solution for heavy metals like lead, cadmium, bismuth and tin
   b. Dummy the solution by electroless methods or electrolytically at low current density and large cathode area to remove contaminants

c. Dispose of the bath if b) is not successful and make up a new one
d. Identify and eliminate the source of contamination. Look for: Racks or barrels that have been used in incompatible processes like cadmium; contaminated rinses; drag in blind holes or pores; parts plated with poisonous metals; drainage from adjacent equipment; impurities in process water

7. **Improper pretreatment**
   a. Confirm that the appropriate pretreatment procedure has been used
   b. After acid activation, examine parts for water breaks, and if present, reprocess and improve pretreatment cycle
   c. Ensure that the pretreatment procedure is not etching the parts
   d. Check that cleaners will remove (dissolve) the machining or cutting oils
   e. If cleaner cannot remove them, change to a different type of oils or a different cleaner
   f. Do not use inhibitors or wetting agents in activating acids

8. **Excessive bath age**
   a. Check bath records or analyze the bath for orthophosphate to determine the bath's age
   b. If older than normal range for bath (often equals 1 or 2 mol/L of ortho), dispose of the bath and make up a new one
   c. If cloudy, add 1% by volume glycolic or lactic acid to clear the solution and then increase the bath's pH to its proper range with 50% ammonia or potassium carbonate

Poor Corrosion Resistance

1. **Pitting or porous deposits**
   a. Test the porosity of the coating according to ASTM B-733
   b. See the section on porous deposits above

2. **Inadequate deposit thickness for application**
   a. Measure the thickness of the deposit using a properly calibrated thickness tester to determine if it is as specified
   b. Evaluate the corrosion environment with the customer to determine whether the deposit offers adequate resistance
   c. Increase the deposit thickness

3. **Inadequate adhesion**
   a. Test the adhesion of the coating to the substrate according to ASTM B-733 or AMS 2404
   b. See the sections on poor adhesion above

4. **Low phosphorous content**
   a. Measure the phosphorous content of the deposit
   b. For most environments, deposits containing more than 11% phosphorus provide the best corrosion resistance
   c. Use a "high phos" type plating bath for most applications

5. **Too high phosphorous content**
   a. Measure the phosphorous content of the deposit
   b. For hot alkali solutions, deposits containing less than 4% phosphorous provide the best corrosion resistance
   c. Use a "low phos" type plating bath for these applications

6. **Excessive bath age**
    a. Check bath records or analyze the bath for orthophosphate to determine the bath's age
    b. The corrosion resistance of most coatings declines rapidly after 4 or 5 cycles of operation
    c. If colder than normal range for bath (often equals 1 or 2 mol/L of ortho), dispose of the bath and make up a new one

7. **Low or high reducer content**
    a. Analyze the bath's reducer content and adjust it to its proper range
    b. Low reducer concentration will cause the phosphorous content and corrosion resistance of "high phos" type coatings to decline
    c. High reducer concentration will cause the phosphorous content and corrosion of "low phos" type coatings to increase
    d. Ensure that the plating tank's volume, used to determine replenishment amounts, is correct
    e. Ensure that the proper ratio of hypo to nickel replenishers has been used (generally either 1:1 or 2:1)

8. **High or low pH**
    a. Measure the bath's pH with a calibrated pH meter and adjust it to its proper range (generally between 4.8 and 5.2 pH) with 50% ammonia or potassium carbonate or 50% sulfuric acid
    b. High pH will cause the phosphorus content and corrosion resistance of "high phos" type coatings to decline
    c. Low pH will cause the phosphorus content and corrosion of "low phos" type coatings to increase
    d. Recalibrate the pH meter or check the accuracy of pH papers used
    e. Eliminate any sources of alkali or acid drag in, such as blind holes and poor rinsing
    f. Confirm that the proper ratio of hypophosphite to nickel replenisher is being used (for self pH regulating baths)

9. **Metallic contamination**
    a. Analyze the solution for heavy metals like lead, cadmium, bismuth and tin
    b. Dummy the solution by electroless methods or electrolytically at low current density and large cathode area to remove contaminants
    c. Dispose of the bath if b) is not successful and make up a new one
    d. Identify and eliminate the source of contamination. Look for: Racks or barrels that have been used in incompatible processes like cadmium; contaminated rinses; drag in blind holes or pores; parts plated with poisonous metals; drainage from adjacent equipment; impurities in process water

10. **Organic contamination**
    a. Check that organic maskants are properly cured and compatible with electroless nickel solutions
    b. Identify and eliminate other sources of contamination, such as from the air supply, drainage from overhead equipment, ethylene glycol, plastic components, and drag in of inhibitors or wetting agents
    c. Check steam coils or heaters for leaks and repair or replace if necessary
    d. Carbon treat the solution by circulating it through carbon cartridges or a packed filter
    e. Dispose of the bath if d) is not successful and make up a new one

11. **High drag out losses (loss of complexers)**
    a. Measure nickel concentration of rinse after the plating tank and calculate the amount of bath being lost
    b. Loss of complexers will cause the phosphorous content of "high phos" deposits to decline

c. Reduce drag out by draining or spray rinsing the parts over the plating tank before placing them in the rinse tank
d. Add small amounts of make up concentrate (typically 1-2% per bath cycle) to replace the complexer being lost

12. **Poor bath control**
    a. Ensure that the bath's temperature, pH, and concentration are maintained within the proper range
    b. Install an automatic bath controller to make more frequent additions to keep the bath in balance

High Deposit Stress

1. **Incorrect phosphorous content**
    a. Measure the phosphorous content of the deposit
    b. Deposits containing more 11% or less 4% phosphorous are compressively stressed; "med phos" deposits can be highly tensile
    c. Use a "high phos" or "low phos" type plating baths

2. **Excessive bath age**
    a. Check bath records or analyze the bath for orthophosphate to determine the bath's age
    b. The internal stress of most coatings increases rapidly after 4 or 5 cycles of operation
    c. If older than normal range for bath (often equals 1 or 2 mol/L of ortho), dispose of the bath and make up a new one

3. **Low or high reducer content**
    a. Analyze the bath's reducer content and adjust it to its proper range
    b. Low reducer concentration will cause the phosphorous content of "high phos" type coatings to decline and their stress to increase
    c. High reducer concentration will cause the phosphorous content and stress of "low phos" type coatings to increase
    d. Ensure that the plating tank's volume, used to determine replenishment amounts, is correct
    e. Ensure that the proper ratio of hypo to nickel replenishers has been used (generally either 1:1 or 2:1)

4. **High or low pH**
    a. Measure the bath's pH with a calibrated pH meter and adjust it to its proper range (generally between 4.8 and 5.2 pH) with 50% ammonia or potassium carbonate or 50% sulfuric acid
    b. High pH will cause the phosphorous content of "high phos" type coatings to decline and their stress to increase
    c. Low pH will cause the phosphorous content and stress of "low phos" type coatings to increase
    d. Recalibrate the pH meter or check the accuracy of pH papers used
    e. Eliminate any sources of alkali or acid drag in, such as blind holes or poor rinsing
    f. Confirm that the proper ratio of hypophosphite to nickel replenisher is being used (for self regulating baths)

5. **Metallic contamination**
    a. Analyze the solution for heavy metals like lead, cadmium, bismuth and tin
    b. Dummy the solution by electroless methods or electrolytically at low current density and large cathode area to remove contaminants
    c. Dispose of the bath if b) is not successful and make up a new one

d. Identify and eliminate the source of contamination. Look for: Racks or barrels that have been used in incompatible processes like cadmium; contaminated rinses; drag in blind holes or pores; parts plated with poisonous metals; drainage from adjacent equipment; impurities in process water

6. **Organic contamination**
   a. Identify and eliminate other sources of contamination, such as from the air supply, drainage from overhead equipment, ethylene glycol, plastic components, and drag in of inhibitors or wetting agents
   b. Check steam coils or heaters for leaks and repair or replace if necessary
   c. Carbon treat the solution by circulating it through carbon cartridges or a packed filter
   d. Dispose of the bath if d) is not successful and make up a new one

7. **High drag out losses (loss of complexers)**
   a. Measure nickel concentration of rinse after the plating tank and calculate the amount of bath being lost
   b. Loss of complexers will cause the phosphorous content of "high phos" deposits to decline
   c. Reduce drag out by draining or spray rinsing the parts over the plating tank before placing them in the rinse tank
   d. Add small amounts of make up concentrate (typically 1-2% per bath cycle) to replace the complexer being lost

8. **Poor bath control**
   a. Ensure that the bath's temperature, pH, and concentration are maintained within the proper range
   b. Install an automatic bath controller to make more frequent additions to keep the bath in balance

Brittle Deposit

1. **Heat treatment**
   a. Check heat treatment records or measure the deposit's hardness to determine its heat treatment
   b. Heat treating electroless nickel deposits causes their ductility to decline
   c. For maximum ductility do not heat treat coatings at temperatures over 550F (290C) or to hardness over 700 HV100

2. **Low phosphorous content**
   a. Measure the phosphorous content of the deposit
   b. Normally, deposits containing more than 10 ½ or 11% phosphorous have the highest ductility
   c. The ductility of deposits with lower phosphorous contents is significantly reduced

3. **Excessive bath age**
   a. Check bath records or analyze the bath for orthophosphate to determine the bath's age
   b. The ductility of most coatings declines rapidly after 5 or 6 cycles of operation
   c. If older than normal range for bath (often equals 1 or 2 mol/L of ortho), dispose of the bath and make up a new one
4. **Metallic contamination**
   a. Analyze the solution for heavy metals like lead, cadmium, bismuth and tin
   b. Dummy the solution by electroless methods or electrolytically at low current density and large cathode area to remove contaminants

c. Dispose of the bath if b) is not successful and make up a new one
d. Identify and eliminate the source of contamination. Look for: Racks or barrels that have been used in incompatible processes like cadmium; contaminated rinses; drag in blind hole or pores; parts plated with poisonous metals; drainage from adjacent equipment; impurities in process water

5. **Low reducer content**
   a. Analyze the bath's reducer content and increase it to its proper range
   b. Low reducer concentration will cause the deposit's phosphorous content and ductility to decline
   c. Ensure that the plating tank's volume, used to determine replenishment amounts, is correct
   d. Ensure that the proper ratio of hypo to nickel replenishers has been used (generally either 1:1 or 2:1)

6. **High pH**
   a. Measure the bath's pH with a calibrated pH meter and reduce it to its proper range (generally between 4.8 and 5.2 pH) with 50% sulfuric acid
   b. High pH will cause the deposit's phosphorous content and ductility to decline
   c. Recalibrate the pH meter or check the accuracy of the pH papers used
   d. Eliminate any sources of alkali drag in, such as blind holes and poor rinsing
   e. Confirm that the proper ratio of hypophosphite to nickel replenisher is being used (for self pH regulating bath's)

7. **High drag out losses (loss of complexers)**
   a. Measure nickel concentration of rinse after the plating tank and calculate the amount of bath being lost
   b. Loss of complexers will cause the deposit's phosphorous content and ductility to decline
   c. Reduce drag out by draining or spray rinsing the parts over the plating tank before placing them in the rinse tank
   d. Add small amounts of make up concentrate (typically 1-2% per bath cycle) to replace the complexer being lost

8. **Excessive stabilizer**
   a. Ensure that the proper ratio of hypo to nickel replenishers has been used (generally either 1:1 or 2:1)
   b. Where possible, analyze the solution for stabilizers like lead and cadmium
   c. If possible, discard part of the bath and adjust with replenisher to bring the solution into balance
   d. If not, dispose of the bath and make up a new one

Poor Wear Resistance

1. **Improper heat treatment**
   a. Check heat treatment records or measure deposits hardness to determine its heat treatment
   b. Increase the temperature or time of treatment to obtain the desired hardness and wear resistance
2. **Low phosphorous content**
   a. Measure the phosphorous content of the deposit
   b. After heat treatment, deposit's containing more than 10 ½ or 11% phosphorous have the highest hardness and generally provide the best wear resistance
   c. Use a "high phos" type plating bath for applications that are heat treated

3. **Too high phophorous content**
    a. Measure the phosphorous content of the deposit
    b. In the as deposited condition, deposits containing about 4% phosphorous have the highest hardness and generally provide the best wear resistance
    c. Use a “low phos” type plating bath for applications that will not be heat treated

4. **Inadequate adhesion**
    a. Test the adhesion of the coating to the substrate according to ASTM B-733 or AMS 2404
    b. See the sections on poor adhesion above

5. **Brittle deposit**
    a. Observe the deposit after wear or wear test to see if it is shattering or crumbling
    b. See the section above on brittle deposits

6. **Excessive bath age**
    a. Check the bath records or analyze the bath for orthophosphate to determine the bath’s age
    b. The ductility and wear resistance of many coatings declines rapidly after 5 or 6 cycles of operation
    c. If older than normal range for bath (often equals 1 or 2 mol/L of ortho), dispose of the bath and make up a new one