2. Process Description

Operations in the Myrtle Beach complex include Raw Materials Manufacturing (RMM), Slip Manufacturing, Metals Department, CMAP Buildup, CMAP Support Department, Kiln Room, Metallization Department and other supporting processes. Detailed descriptions of the processes are given in the following sections. Process descriptions emphasize material flow, as AVX uses a material mass balance approach to track emissions. Please refer to the process flow diagrams in Appendix C and the equipment inventory entered on DHEC "Section D" forms in Appendix E.

2.1 Raw Materials Manufacturing (Unit ID 14)

The chip manufacturing process at AVX begins with the Raw Materials Manufacturing department (RMM). Individual metal salt are blended together with water and dispersants in a batch process to produce a formulated ceramic compound. The ceramic material is then ground and milled to reduce particle size. Ceramic powder is prilled to reduce water content by placing the material on a belt moving through a heater. The material is then either fired to physically react the constituents or further dried to remove excess moisture and dispersant.

Emissions from this portion of the RMM are primarily particulate matter (PM) emissions from grinding and milling operations. These emissions are controlled by three baghouses.

It should be noted that the chemical barium titrate process, and associated equipment, is no longer in operation in the RMM Department.

2.2 Slip Manufacturing (Unit ID 15)

Ceramic powders from RMM are transferred to the Slip Manufacturing department building. The powders are blended with organic solvents such as butyl cellosolve (BC) and propylene glycol monomethyl ether (PGME) to produce a flow able ceramic slurry, also known as slip.

Mixing takes place in various sized, mixing vessels, and holding tanks as appropriate to prepare a particular slurry batch. The slurry is mixed and milled to achieve the necessary particle size distribution. Mixing and milling occurs primarily in sealed or covered containers to maintain specific product viscosity specifications. This limits the VOC and HAP emissions generated from the mixing of solvents with the powder and equipment cleaning. The emissions are vented to the atmosphere through a single room vent and as fugitive emissions through windows and door openings.

Emission estimations are based on 100% loss or a percentage loss depending on the material used (manufacturing or equipment cleaning). From process engineering knowledge required to meet viscosity specifications when manufacturing slip, material rework, and waste recovery, solvent losses are less than 1%. In communications between AVX and DHEC, it has been agreed to estimate emissions through conservative loss factors of 10% or 20%, depending on the uses of the organic material.

2.3 Metals Department (Unit ID 16)

In the metals department, conductive metal inks (electrode inks) and pastes (termination pastes) are produced. The process is similar to slip manufacturing where solvents and fillers (organic binders) are added to powders, blended, and then milled to achieve the proper particle size distribution. VOC and HAP are emitted during mixing and milling through air conditioning vents and exhaust vents that have no pollution abatement.

Similar to slip manufacturing, emission estimations are based on percentage losses depending on the material used (manufacturing or equipment cleaning). From process engineering knowledge required to meet viscosity specifications when manufacturing slip, material rework, and waste recovery, solvent losses are less than 1%. In communications between AVX and DHEC, it has been agreed to estimate emissions through conservative loss factors of 10% or 20%, depending on the uses of the organic material.

2.4 CMAP Buildup (Unit ID 17)

In the Chip Manufacturing Automated Process (CMAP) operations, capacitors are produced in a "build-up" process in which the ceramic slip is laid down with alternating layers of electrode ink on glass plates. A conservative rate of 70 kg of slip is processed per CMAP machine per day has been used for emission estimation purposes. Approximately 15% of this amount is collected for material reclaim.

VOC in slip and ink are emitted during application of the materials when manufacturing the capacitors. The CMAP machines are designed with enclosures for capture and control of emissions. Exhausts are vented to a VOC abatement control system consisting of three (one 14,500 acfm and two 5,000 acfm) parallel adsorber/ desorber units in series with one thermal oxidizer. On February 26, 2009 a destruction test was performed on one 5,000 acfm adsorber/desorber unit and thermal oxidizer. Results demonstrated a thermal destruction efficiency of 99.99% and an overall VOC removal efficiency of 99.5%. However, AVX will use an achievable 98.5% control efficiency in emission rate calculations for conservatism.

Prior to moving capacitor tools, qualification procedures must take place between AVX and its customers. As a result, two CMAP machines will remain at the original manufacturing location through the majority of 2010 for qualification. The total number of CMAP machines (new and old location) is 24.

A small amount of HAPs are present in denatured alcohol used for machine cleaning. Until recently, xylene has been is also used for cleaning; however, AVX has replaced xylene with n-butyl acetate in the CMAP Department.

2.5 CMAP Support Department (Unit ID 18)

CMAP Support consists of a number of processes that support the CMAP buildup activities.

- Glass buildup plate preparation
- Dicing operations
- Chip removal
- Green chip corner rounding
- Chip drying (moisture removal)
- Formation of cured ceramic chip body (burnout and firing)

The glass plates used in the CMAP buildup process are prepared in CMAP Support by water washing, drying, and applying a release paper or plastic film to the plate. This is the surface onto which the buildup of ceramic slip and electrode ink occurs in CMAP buildup process and allows for easy removal of the individual chips after dicing.

Once the ceramic and electrode ink layers have been created on the glass plates, the ceramic buildup is cut or "diced" into predetermined shapes and sizes to form individual capacitor chips. The majority of dicing is accomplished using a wet process where there are now emissions. For certain product lines, dicing is completed using a dry process that results in a small amount of PM.

Emissions from CMAP Support include VOC from cleaning solvents and PM from the dry dicing operations. Spent cleaning solvent waste is collected and removed from CMAP Support. Baghouses are used to control PM emissions from dry dicing.

The individual capacitors created from dicing are known as "green" chips prior to the burn out and sintering steps. In the green chip area, chips are sorted, washed, dried at low temperatures, and corner rounded. The average time chips spend in this area is 5.5 days. AVX contends that no volatile organic compounds (HAP/TAP) are present in the chips after this process step when entering the Kiln Room. A small amount organic material is present in the binder removed from the chips during the burn out ovens.

CMAP Support includes the Kiln Room, which contains electric burn out ovens and firing kiln ovens. The green chips enter burnout ovens to remove electrode ink binder material prior to ceramic firing. The burnout cycle time ranges from about 24 hours to as high as 30 hours with temperatures peaking at around 500 degrees F in inert and oxidizing atmospheres. After the binder material is evacuated from the chips, they enter the kilns to fire and cure (sinter) the ceramic. Average firing cycle time is 33 hours reaching a maximum temperature of 2300 degrees F.

On June 25, 2009, AVX conducted carbon sampling from an exhaust of one of the burn out ovens. The test indicated a small amount of VOC (as carbon) emissions during this processing step. Based on these results, AVX contends that all organic material is vacated from the chips during burn out and, therefore, the kilns are sources of heat emissions only.

To simplify the revised permit, the burnout ovens will be considered as part of the CMAP Support department. Therefore, the Kiln Room will no longer be a separate emission unit.

2.6 Metallization Department (Unit 19)

Metallization Department operations include the chip termination and plating processes. Previously, Termination and Plating Departments were separate emission units. To streamline the AVX Title V permit, these departments have been combined.

2.6.1 Termination

The termination process is the application of metal paste to capacitor chips to make the connection to the internal electrode layers. After application of the termination paste, the chips are fired on a time-temperature profile to bond the paste material to the electrode end of the capacitor. VOC in the termination paste are emitted during the application and curing and exhausted through room exhausts. VOC and HAP emissions also result from solvents used to clean the equipment. Xyxlene is one of the solvents used for cleaning. AVX is in the process of

replacing xylene used for cleaning in the termination area with propylpionate, a non-HAP organic.

2.6.1 Plating

Following termination, the electrode layer connections are then plated to provide a surface suited for solder application for product quality. This department is currently permitted to operate five Autoline Barrel platers, a gold plating line, and three RFT batch plating processes. There is currently only one 6-position Autoline in operation, which is scheduled for decommissioning some time in 2011. The RFT platers are no longer in operation. Spouted Bed Electrode (SBE), Fine Copper Termination (FCT), and BCB coating processes will remain in their present location for the foreseeable future. Small amounts of particulate matter, nickel, and lead are potentially emitted from the plating solutions in two of the SBE lines and the Autoline.

2.7 Supporting Processes (Unit ID 21)

In addition to the processes listed above there are a number of other activities at AVX that support the manufacturing processes. Equipment such a boiler, soldering pots, and ground water air stripping emit small amounts of criteria pollutants and HAP and are included in the Miscellaneous Support source group.

2.8 Trivial and Insignificant Activities

In addition to the equipment described above, there are several processes which are categorized as insignificant per classification in the Title V regulations. This includes emergency generators, small boilers, a fire water pump, laboratory equipment, and R&D.