1.0 Identification of Available PM Control Technologies

1.1 Available PM Control Technologies

PM control technologies that were identified as available for retrofit at SJGS are listed below. Only post-combustion control is available for PM control. A short summary of each technology is included in the following sub-sections:

– Pulse Jet Fabric Filter

– Wet Electrostatic Precipitator (WESP)

1.1.1 Pulse Jet Fabric Filter (PJFF)

As part of the consent decree environmental upgrade project, a PJFF system will be installed on each of the four units at SJGS. The PJFFs will be installed downstream of the existing hot-side ESPs and air heaters, and upstream of the wet flue gas desulfurization (FGD) system. After the commissioning of the PJFF, the hot-side ESP will be de-energized.

In addition to particulate removal, the PJFF system being installed is also part of the emission control system for Hg emission reduction. Activated carbon will be injected into the flue gas downstream of the air heater for adsorption of Hg in the flue gas. The PJFF is used to capture the Hg-laden activated carbon and other PM.

The PJFF outlet will be connected to the existing wet FGD system for SO_2 emissions removal from flue gas. The wet FGD system is equipped with mist eliminators for the removal of entrained moisture droplet, which might also contain unreacted reagent (limestone particle in the slurry) from the FGD or byproduct particulates (calcium sulfite or calcium sulfate). These are also known as re-entrained scrubber solids.

While the control effectiveness of the PJFF is usually defined by vendors at the outlet ductwork of the PJFF, the BART determination is based on the control effectiveness for particulate matter at the stack outlet. Therefore, the particulate matter emission rate has to take into account both the removal efficiency of the PJFF and the impacts of the wet FGD operation, where there is a potential for additional re-entrainment of scrubber solids into the flue gas, which increases the stack outlet particulate matter emission concentration. In this BART determination for particulate matter, the control effectiveness defined for the PJFF installed at SJGS for consent decree requirements, takes into account the impacts of operating the wet FGD system. The overall particulate matter emissions will be the cumulative removal efficiency of the consent decree PJFF and the mist eliminators of the wet FGD.

NMED EX. 7o

1.1.2 Wet Electrostatic Precipitator (WESP)

A WESP collects particles on the same theoretical basis as a dry ESP: negatively charged particles are collected on positively charged surfaces. However, the collecting surfaces are wet instead of dry and are flushed with water to remove the particulate. Typically, a WESP is installed downstream of an existing wet FGD system where the flue gas is already saturated, so the amount of added water is minimized. The particulate collection efficiency is enhanced by a lack of re-entrainment after contact with the wet walls (as contrasted with re-entrainment due to rapping on a dry ESP). Therefore, the WESP can remove fine particulate or acid mist applications because it reduces opacity, sulfuric acid mist (H_2SO_4), and other aerosols.

A WESP can be installed in either horizontal or vertical gas flow orientation. In a horizontal gas flow orientation, a WESP is similar to a common dry ESP, and is located on the grade elevation of the plant. Vertical gas flow WESPs are usually of the tubular collection plate type, and is typically used if installed as part of the wet FGD absorber module. Since the existing wet FGD system at SJGS consists of a multiple absorber tower arrangement, the vertical flow wet ESP was not selected as it is more suited for retrofit on wet FGD systems with a single absorber tower. The horizontal flow wet ESP is therefore considered as the baseline design for this analysis.

The WESP will be installed downstream of the existing wet FGD system with the consent decree PJFF in operation to remove a significant amount of particulate matter prior to the flue gas entering the wet FGD system. The moisture saturated flue gas at the wet FGD outlet will then be flowed through the WESP for additional particulate matter removal. In addition to PM, condensible particulate matter (including acid mist), will be effectively removed at the WESP.

An alternative WESP arrangement where it is located upstream of the wet FGD system with the consent decree PJFF decommissioned was not considered for the following reasons. The inlet ductwork into the WESP would need to have a quenching system to saturate flue gas with moisture. The WESP casing would also have to be larger as more electrical fields would be needed for the higher particulate loading. A larger quantity of collected particulate matter from the WESP would also have to be removed from the collector plate wash water. Due to the increase in WESP casing size and retrofit complexity of the additional flue gas quenching and wash water treatment system, this arrangement for the WESP was not considered. In addition to that, the treated flue gas from the WESP will flow through the wet FGD system, where impacts of the wet FGD operations, as described in Subsection 1.1.1 will increase the stack outlet PM emission concentration.

2.0 Technical Feasibility of PM Control Technologies

2.1 Technically Feasible PM Control Technologies

In the process of eliminating technically infeasible alternatives, it is necessary to demonstrate that a technology is not applicable or not available for application at the source. This demonstration is made by showing that the technology is commercially unavailable and/or there are insurmountable technical difficulties with applying the technology to the applicable unit. Other factors that are considered when determining the technical feasibility of a technology include the following:

- Size of the unit.
- Location of the proposed technology.
- Operating problems after retrofit of technology.
- Space constraints.
- Reliability.
- Adverse effects on the rest of the facility.
- Adverse community impacts.

Additionally, a technology is technically infeasible if its level of emissions control does not achieve the required permit emissions limit applied to the source by the regulating agency. Finally, if there are multiple control technologies that have an equivalent level of control, the BART procedure allows for the consideration of the less costly control technology, therefore eliminating the need to evaluate higher cost technologies.

For all the PM control technologies identified as available, a determination was made regarding the technical feasibility of the technology at the SJGS site on the basis of the criteria highlighted above.

2.1.1 PJFF

The PJFF is currently being installed at SJGS for the consent decree environmental upgrade project. Therefore, this technology combination is technically feasible for the reduction of PM emissions.

2.1.2 WESP

The WESP technology is based on the fundamentals of the ESP technology. WESP have also been installed in flue gas streams downstream of a Wet FGD for the removal of PM. Therefore, this technology is technically feasible.

2.2 Technical Feasibility Summary

Table 2-1
Technically Feasible PM Control Technology Alternatives

Pollutant	Philosophy	Technology	Technically Feasible and Applicable?	Remarks/Reasons for Technical Infeasibility
PM	Control Technologies:	PJFF	Yes	In the process of being installed in response to the Consent Decree with existing wet FGD system in operation.
		WESP	Yes	Technically feasible arrangement includes operating the Consent Decree PJFF and existing wet FGD system.

3.0 Evaluation of Technically Feasible Retrofit PM Emissions Control Technologies

This section discusses the control effectiveness evaluation of technically feasible PM control technologies beyond that achieved currently by the newly installed PJFF for the consent decree.

3.1 Control Effectiveness

The evaluation process in Step 3 determines the control effectiveness of the technically feasible PM control technologies. Control effectiveness is expressed in a common metric based on the amount of pollutant generated per unit of heat input (lb/MBtu). The evaluation of the control effectiveness was translated into an hourly rate (lb/h) for each pollutant, according to the design basis heat input data for each SJGS unit. The evaluation of control effectiveness was based on information indicated in Subsection 1.2.3.

Table 3-1 indicates the control effectiveness of each PM control technology. This control effectiveness was calculated from the consent decree values established for front half, filterable particulate matter at 0.015 lb/MBtu.

The control effectiveness for each technology is also summarized in the Design Concept Definition tables in ***Appendix B***.

Table 3-1
Control Effectiveness for PM Control Technology Alternatives (Annual Average Emissions Rates)

Unit	SJGS 1			SJGS 2			SJGS 3			SJGS 4		
Design Basis Heat Input Data, MBtu/h	3,707			3,688			5,758			5,649		
PM Emissions Cases	lb/MBtu	lb/h	ton/yr	lb/MBtu	lb/h	ton/yr	lb/MBtu	lb/h	ton/yr	lb/MBtu	lb/h	ton/yr
PJFF (consent decree)	0.015	55.6	207	0.015	55.3	207	0.015	86.4	321	0.015	84.7	315
WESP	0.010	37.1	138	0.010	36.9	137	0.010	57.6	214	0.010	56.5	210

Notes:
1. Emissions levels (lb/MBtu) shown are on an annual average basis, front-half filterable PM only.
2. Emissions (lb/h) calculations were based on the emissions level (lb/MBtu) and design basis heat input.
3. Emissions levels listed were based on performance guarantees provided by the equipment vendor.
4. Yearly emissions (ton/yr) calculations were based on an annual unit capacity of 85 percent.

4.0 Cost-Effectiveness of PM Control Technologies

This section discusses the cost-effectiveness for PM control technologies considered in this BART analysis.

4.1 Cost-Effectiveness

The cost-effectiveness of each control technology was calculated from the cost of compliance and the amount of pollutant reduced. The cost-effectiveness is defined as the cost of control per amount of pollutant removed. The cost of control takes into account the impact analyses performed. The reduced emissions were estimated on a yearly basis according to the reduction from the consent decree emissions level shown in Table 3-1. Both the consent decree emissions level and the additional control technology alternative emissions level are documented in Table 3-1 and in the Design Concept Definition tables (***Appendix B***).

The cost-effectiveness values were based on 2007 dollars.

4.2 Impact Analysis and Cost-Effectiveness Results

An impact analysis was performed for all the identified technically feasible control technologies. A summary of the calculated impact analysis is presented in ***Appendix C***. The impact analysis of WESP includes auxiliary energy to power the WESP and fans, and an estimate of the additional water consumption requirements when operating the WESP. Water is consumed when collector plate wash water is re-entrained into the flue gas flow, as well as waste water discharged from WESP through the blow down process to maintain the wash water chemical properties. The cost of this impact is significant due to the scarcity of water in the region where SJGS is located.

For all the additional PM control technologies evaluated, a summary table was developed for the impact analysis performed and the resultant cost-effectiveness. Table 4-1 presents the final evaluations for all four units. The expected post-control emissions levels are also included in the table.

Table 4-1
Impact Analysis and Cost-Effectiveness Results of PM Control Technologies

All Feasible Technologies	Emission Performance Level (lb/MBtu)	Expected Emission Rate (lb/h)	Expected Emission Rate (ton/yr)	Expected Emission Reduction (ton/yr)	Total Capital Investment (TCI) (1,000$)	Total Annualized Cost (TAC) (1,000$)	Incremental Cost Effectiveness ($/ton)	Energy Impacts (1,000$)	Non-Air Impacts (1,000$)
SJGS Unit 1									
WESP (see note 8)	0.010	37.1	138	69	99,308	11,855	171,797	1,112	--
PJFF (see note 9)	0.015	55.6	207	--	67,072	10,427	--	4,488	--
SJGS Unit 2									
WESP (see note 8)	0.010	36.9	137	69	99,663	11,895	173,265	1,112	--
PJFF (see note 9)	0.015	55.3	206	--	69,840	10,764	--	4,488	--
SJGS Unit 3									
WESP (see note 8)	0.010	57.6	214	107	129,565	15,558	145,151	1,728	--
PJFF (see note 9)	0.015	86.4	322	--	72,696	12,454	--	6,895	--
SJGS Unit 4									
WESP (see note 8)	0.010	56.5	210	105	130,012	15,609	148,436	1,728	--
PJFF (see note 9)	0.015	84.7	315	--	73,328	12,527	--	6,895	--

Notes:

1. All costs are in 2007$.
2. Expected emission rates (ton/yr) calculations were based on 85 percent unit capacity factor (referer to Appendix A Design Basis).
3. Expected emission reduction (ton/yr) calculations were based on the consent decree upgrades control effectiveness as shown in Table 4-1.
4. TCI and TAC are referenced from Appendix C Cost Analysis Summary.
5. Cost-effectiveness ($/ton) is defined as ratio of TAC over Expected Emission Reduction (ton/yr).
6. Expected emission reduction is based on annual emission reduction from consent decree upgrade emission levels (Table 4-1).
7. Incremental cost effectiveness are based on increments in expected emission reduction (ton/yr).
8. WESP scenario includes operating consent decee PJFF and existing wet FGD system.
9. PJFF scenario includes operating existing wet FGD system.

4.2.1 Cost-Effectiveness Comparison

The Total Capital Investment (TCI) and Total Annualized Cost (TAC) for the consent decree PJFF at SJGS as shown in Table 4-1 are based on the values submitted in the June 6, 2007 BART application. The emission performance level of the consent decree PJFF at 0.015 lb/MBtu for front-half, filterable PM is the contract guarantee emission level for the on-going consent decree required environmental upgrade project at SJGS. This emission performance level is based on measuring PM emissions at the stack, which takes into account the impacts of operating the wet FGD system downstream of the newly-installed consent decree PJFF. The TCI for the consent decree PJFF ranges from $67 million to $73 million per SJGS unit.

The WESP technology when operated downstream of the consent decree PJFF and existing wet FGD system will achieve an expected emission performance level of 0.010 lb/MBtu for front-half, filterable PM. The corresponding TCI for the WESP ranges from $99 million to $130 million per SJGS unit.

The increment cost effectiveness to improve PM emission level from the consent decree level of 0.015 lb/MBtu to 0.010 lb/MBtu utilizing the WESP technology in addition to operating the consent decree PJFF and wet FGD system ranges from $145 to $173 million per additional ton of PM.

5.0 Visibility Impacts

Visibility impact is the fifth step to consider in the engineering analysis required under the EPA BART guidelines. This step addresses the degree of improvement in visibility that may reasonably be anticipated to result from the use of the ''best control technology'' for sources subject to BART. Visibility impact analysis is achieved through a two phase process. First, the model was run using the pre-BART conditions to establish a baseline. For this analysis, the baseline consisted of the technologies and unit operations associated with the consent degree. Second, model runs were conducted for the WESP PM control technology identified for each unit during the BART engineering analysis.

In the June 18, 2008 meeting between the Public Service Company of New Mexico (PNM), Black & Veatch (B&V), and the New Mexico Environment Department – Air Quality Bureau (NMED), the NMED requested additional analyses be performed for the particulate control technology that could meet a lower limit than 0.015 lb/MBtu. The objective of this modeling analysis is to evaluate visibility impacts for the WESP control technology selected using the first four steps of the BART analysis (as discussed in the previous sections) for PNM's SJGS Units 1, 2, 3, and 4. The following sections discuss the modeling methodology in greater detail.

5.1 Visibility Analysis

Subsequent to the June 6, 2007 submittal, PNM further investigated additional refinements to the BART CALPUFF air dispersion modeling analyses which included nitrate repartitioning and more realistic ammonia background concentrations based on monitored values at several western Class I areas. These additional modeling options are considered more realistic and therefore will again form the basis of this analysis.

To date, PNM has previously submitted four BART modeling analyses in addition to the additional Nalco Mobotec analyses being submitted separately but coincident with this analysis. To clarify the contents of these analyses, as well as for this submittal, a summary of each has been provided:

June 6, 2007

Modeling analysis were performed to provide SJGS plant-wide regional haze (visibility) impacts at 16 Class I areas. The analyses were based on a constant 1 ppb background ammonia concentration and no nitrate repartitioning. The NO_x control technologies analyzed were the Selective Catalytic Reduction (SCR) and SNCR/SCR Hybrid.

November 6, 2007

Modeling analysis were performed to provide SJGS plant-wide regional haze (visibility) impacts at 16 Class I areas. The analysis was based on refinements which included using the nitrate repartitioning methodology and monthly variable background ammonia concentrations. Again, the NO_x control technologies analyzed were the SCR and SNCR/SCR Hybrid.

March 31, 2008

Two main modeling analyses were performed to provide SJGS plant-wide and unit specific regional haze (visibility) impacts at 16 Class I areas for the SCR NO_x control technology only. One of the analyses, believed to be the more representative of ammonia chemistry of the area, was based on the November 6, 2007 refinements which included using the nitrate repartitioning methodology and monthly variable background ammonia concentrations. The other analyses included nitrate repartitioning and a constant background ammonia concentration as requested by the NMED.

May 30, 2008

Two modeling analyses were performed to provide SJGS plant-wide and unit specific regional haze (visibility) impacts at 16 Class I areas for the SNCR NO_x control technology only. Similar to the March 31, 2008 analyses, one of the analyses was based on the November 6, 2007 refinements which included using the nitrate repartitioning methodology and monthly variable background ammonia concentrations. The other analyses included nitrate repartitioning and a constant background ammonia concentration. It should be noted that all vendors of SNCR (including Fuel Tech and Nalco Mobotec) have been modeled together as one technology called SNCR. This is the same approach that is used for modeling SCR control technology, where all vendors are modeled generically as SCR.

August 29, 2008

Four modeling analyses were performed to provide SJGS plant-wide and unit specific regional haze (visibility) impacts at 16 Class I areas for the ROFA with Rotamix, Rotamix, and ROFA NO_x and WESP PM control technologies (the NO_x and PM analyses were submitted separately. Similar to the May 30, 2008 analyses, these analyses were also based on the November 6, 2007 refinements which included using the nitrate repartitioning methodology and monthly variable background ammonia concentrations.

The modeling refinements contained in this submittal using nitrate repartitioning and the variable ammonia background as well as the previous November 2007, March 2008, and May 30, 2008 submittals supersedes the original June 2007 BART modeling analyses as PNM believes these analyses are more representative of regional conditions in the modeling domain, as well as, allow for a more representative visibility analysis. Information pertinent to these two refinements has been included in detail in the previous four submittals. Furthermore, at the June 18, 2008 meeting NMED indicated that based on a current ammonia monitoring study conducted by Mark E. Sather of EPA Region VI, the previous analyses provided utilizing the variable ammonia were representative of the surrounding background. Therefore, no other analyses were performed using nitrate repartitioning and constant background ammonia.

5.2 Visibility Summary

Based on the refinements methodology consisting of representative background ammonia concentrations and nitrate repartitioning, CALPUFF visibility modeling was performed for three cases; pre-consent decree, consent decree (which represents SJGS's BART baseline scenario), and WESP PM control technology scenarios. The modeling summarized in this report is for the SJGS on a plant-wide basis and for each of the four SJGS units on an individual unit basis. It is important to note that all other modeling options as described in the BART application were unchanged. For simplicity, the following results discuss the differences between the consent decree scenario and the WESP control technology scenarios. Additionally, the updated NPS particulate speciation is contained in Appendix D, the stack outlet conditions are contained in Appendix E, and the visibility modeling results are contained in Appendix F.

5.2.1 SJGS Facility Visibility Summary with Nitrate Repartitioning and Variable Ammonia

The results of the refined visibility modeling for the SJGS plant, assuming the same control technology is installed on all four units, are illustrated in Tables 1 through 4 of Appendix F. These tables summarize the scenarios and the maximum visibility (deciview) impact seen at any of the 16 Class I areas at any time over the 2001 to 2003 period. The results of this analysis, using the aforementioned refinements, indicates a minimal improvement in visibility impact (less than 0.5 dv) at each of the 16 Class I areas when compared to the baseline (consent decree) scenario, with the exception of Mesa Verde, which shows a visibility improvement of 0.62 dv.

The maximum visibility (deciview) improvement seen at any of the 16 Class I areas at any time over the 2001 to 2003 period is illustrated in Table 4 for each scenario. The expected degree of visibility improvement for each control scenario for each unit (on a plant-wide basis) was determined by the difference in the maximum visibility improvement for each receptor at each of the sixteen Class I areas. Again, it is important to note that the control technology associated with the consent decree formulated the SJGS's baseline case, as well as the baseline case for the individual unit analyses described later. Additionally, the cost-effectiveness for the potential BART control technologies from the BART application were used to calculate visibility improvement cost-effectiveness in $/deciview ($/dv). Three major scenarios are shown in the visibility improvement cost effectiveness summary in Table 4 for each control technology:

- Pre-consent decree to consent decree.
- Consent decree to additional WESP control technology alternative scenario.
- Pre-consent decree to additional WESP control technology alternative scenario.

These maximum visibility improvements between the consent decree and the WESP control technology scenario range from 0.02 dv to 0.62 dv of expected visibility improvement above the consent decree scenario.

The results indicate that adding additional WESP control technology beyond the consent decree does yield visibility improvement greater than 0.5 dv at the Mesa Verde Class I area. However, this visibility improvement is an isolated incident as no other Class I area's visibility improvement is greater than 0.5 dv. The next highest visibility improvement is 0.14 dv.

Based on the visibility improvement modeled and the total annual cost evaluated in the impact analysis stage of the BART application document, the cost-effectiveness for visibility improvement (annual cost per improvement in visibility, $/dv), was determined for SJGS over the aforementioned range of visibility improvement. The resulting cost for installation of WESP control technology for all four units ranges from $2,496 million/dv to $89 million/dv.

Appendix F contains a SJGS plant-wide summary of the 98th percentile visibility impact for the WESP modeled technology scenarios (i.e., Pre-Consent Decree, Consent Decree, and WESP scenario), provides information on the number of days above 0.5 dv threshold for specific scenarios, and indicates the contribution of each pollutant associated with the 98th percentile visibility impact for each class I area.

5.2.2 Unit Specific Visibility Summary with Nitrate Repartitioning and Variable Ammonia

The results of the refined visibility modeling for Unit 1, Unit 2, Unit 3, and Unit 4 are illustrated in Tables 5-8, 9-12, 13-16, and 17-20 of Appendix F, respectively. These tables summarize the scenarios and the maximum visibility (deciview) impact seen at any of the 16 Class I areas at any time over the 2001 to 2003 period. Similar to results seen for the SJGS facility, the visibility impacts at Mesa Verde represent the maximum visibility impact at any of the 16 Class I areas. In addition, this analysis indicates a minimal improvement in visibility impact (less than 0.5 dv) at each of the 16 Class I areas when compared to the baseline (consent decree) scenario.

The maximum visibility (deciview) improvement seen at any of the 16 Class I areas at any time over the 2001 to 2003 period is illustrated in Tables 8, 12, 16, and 20. Again, the expected degree of visibility improvement for each control scenario for each unit was determined by the difference between the consent decree's maximum visibility improvement for each receptor at each of the sixteen Class I areas and the specific WESP control technology scenario's maximum visibility improvement for each receptor at each of the sixteen Class areas. Furthermore, the same methodology previously described for the SJGS's cost-effectiveness in ($/dv) was used here for each unit.

These maximum visibility improvements between the consent decree and the WESP control scenario for each unit are similar to that of the combined SJGS. The visibility improvements for each scenario are summarized below.

WESP

- Unit 1 improvements range from less than 0.01 dv to 0.07 dv
- Unit 2 improvements range from less than 0.01 dv to 0.07 dv
- Unit 3 improvements range from less than 0.01 dv to 0.21 dv
- Unit 4 improvements range from less than 0.01 dv to 0.21 dv

The results again indicate that adding additional PM control technology beyond the consent decree consisting of WESPs does not yield visibility improvement greater than 0.5 dv at any Class I area. Based on the visibility improvement modeled and the total annual cost evaluated in the impact analysis stage of the BART application document, the cost-effectiveness for visibility improvement (annual cost per improvement in visibility, $/dv), was determined for each unit for each Class I area. The resulting cost for installation of additional control technology for each unit is summarized below.

WESP

- Unit 1 cost range is $2,964 million/dv to $174 million/dv.
- Unit 2 cost range is $2,974 million/dv to $172 million/dv.
- Unit 3 cost range is $2,222 million/dv to $76 million/dv.
- Unit 4 cost range is $3,902 million/dv to $75 million/dv.

Appendix F also includes a unit specific summary of the 98th percentile visibility impact for the three modeled technology scenarios (i.e., Pre-Consent Decree, Consent Decree, WESP scenarios), includes the number of days above 0.5 dv threshold for specific scenarios, and indicates the contribution of each pollutant associated with the 98th percentile visibility impact for each class I area.

6.0 Conclusion

As noted in this document, PNM's further investigation of additional refinements to the June 2007 BART CALPUFF air dispersion modeling analyses to yield more realistic regional haze impacts was warranted. These analyses included nitrate repartitioning and more realistic ammonia background concentrations based on monitored values at several western Class I areas, as well as, the additional ammonia study being conducted by EPA in New Mexico. The conclusion of this study re-iterates and further supports the overall findings of the original June 2007, as well as, the three aforementioned additional submittals, that installation of additional WESP PM control technology systems at the SJGS provide minimal visibility improvements and would require significant capital expenditure and modifications that will impact many areas of the plant including boiler draft systems and ash handling. The results from the analyses further substantiate that the addition of WESP PM control technology does not yield a benefit nor meet the intended goal of BART. Specifically, these analyses indicate:

- The addition of WESP PM control technology on a plant-wide or individual unit basis shows less than a 0.5 dv improvement for all Class I areas including the four Class I areas located in New Mexico. (Plant wide showed a 0.62 dv improvement at Mesa Verde.)
- The minimal visibility improvements discussed in this document do not merit the large capital expenditure required to install WESP PM control technology. Both the total annual costs evaluated and the cost-effectiveness ($/dv) are extremely prohibitive given the minimal improvements realized.

Therefore, as previously noted, given the minimal visibility improvement to the class I areas in the BART analysis, the recommended PM BART control for SJGS is the PJFF.

APPENDICES A – F

OF NMED Ex. 7o

ARE ON CD ONLY