



## Summary of Studies Supporting USDA Product Licensure

|                                                                           |                                                                                                                                                                                                                                                                                                                                                                          |
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| Establishment Name                                                        | Zoetis Inc.                                                                                                                                                                                                                                                                                                                                                              |
| USDA Vet Biologics Establishment Number                                   | 190                                                                                                                                                                                                                                                                                                                                                                      |
| Product Code                                                              | 1187.21                                                                                                                                                                                                                                                                                                                                                                  |
| True Name                                                                 | Bovine Rhinotracheitis-Virus Diarrhea-Parainfluenza 3-Respiratory Syncytial Virus Vaccine, Modified Live & Killed Virus                                                                                                                                                                                                                                                  |
| Tradename(s) / Distributor or Subsidiary (if different from manufacturer) | CattleMaster 4 - No distributor specified<br>CattleMaster 4 - Not Listed<br>CattleMaster 4 - Zoetis Industria Produtos Veterinarios Ltda.<br>CattleMaster 4 - Zoetis Industria de Produtos<br>CattleMaster 4 - Zoetis Korea<br>CattleMaster 4 - Zoetis South Africa Ltd<br>CattleMaster 4 - Zoetis de Chile S.A.<br>Cattlemaster IBR-PI3-BRSV - No distributor specified |
| Date of Compilation Summary                                               | February 16, 2023                                                                                                                                                                                                                                                                                                                                                        |

**Disclaimer: Do not use the following studies to compare one product to another. Slight differences in study design and execution can render the comparisons meaningless.**

| Study Type                        | Efficacy                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                             |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
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| Pertaining to                     | Bovine Viral Diarrhea Virus, type 1 (BVDV 1)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                             |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
| Study Purpose                     | Demonstrate efficacy against respiratory disease caused by BVDV 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                             |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
| Product Administration            | Two doses administered intramuscularly 14 days apart                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                             |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
| Study Animals                     | Thirty-six (36) calves, at least 6 months of age; 24 vaccinates and 12 controls; seronegative for BVD                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                             |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
| Challenge Description             | BVDV 1 virus (non-cytopathic type 1b strain New York-1)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                             |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
| Interval observed after challenge | Clinical observations and rectal temperatures were collected for 3 days pre-challenge and 14 days post-challenge. Blood samples were collected 3 days prior day of challenge and for 14 days following challenge.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                             |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
| Results                           | <div>A scoring system for evaluation of responses of calves following challenge exposure was used:</div> <table><tr><th>Response to Challenge</th><th>Numerical Value (Point/day)</th></tr><tr><td>Temperature Elevation:<br/>Above 1.0°F</td><td>1</td></tr><tr><td>Above 2.0°F</td><td>2</td></tr><tr><td>Above 3.0°F</td><td>3</td></tr><tr><td>Leukopenia:<br/>80-100 % of average leukocyte count</td><td>0</td></tr><tr><td>70-79.9 % of average leukocyte count</td><td>1</td></tr><tr><td>60-69.9 % of average leukocyte count</td><td>2</td></tr><tr><td>50-59.9 % of average leukocyte count</td><td>3</td></tr><tr><td>50% of average leukocyte count</td><td>4</td></tr><tr><td>Clinical Symptoms:<br/>Anorexia</td><td>3</td></tr><tr><td>Diarrhea</td><td>3</td></tr><tr><td>Death</td><td>20</td></tr></table> <div>Total Scores based on points/day:</div> <table><tr><th>Treatment Groups</th><th>Animal ID</th><th>Score</th></tr><tr><td rowspan="12">Controls</td><td>000</td><td>53</td></tr><tr><td>11-17</td><td>42</td></tr><tr><td>1-25</td><td>30</td></tr><tr><td>1-24</td><td>44</td></tr><tr><td>814</td><td>44</td></tr><tr><td>2-30</td><td>54</td></tr><tr><td>2-37</td><td>55</td></tr><tr><td>1-23</td><td>41</td></tr><tr><td>2-29</td><td>31</td></tr><tr><td>3-44</td><td>52</td></tr><tr><td>2-34</td><td>44</td></tr><tr><td>3-43</td><td>52</td></tr><tr><td rowspan="2">Vaccinates</td><td>818</td><td>13</td></tr><tr><td>805</td><td>11</td></tr></table> | Response to Challenge       | Numerical Value (Point/day) | Temperature Elevation:<br>Above 1.0°F | 1 | Above 2.0°F | 2 | Above 3.0°F | 3 | Leukopenia:<br>80-100 % of average leukocyte count | 0 | 70-79.9 % of average leukocyte count | 1 | 60-69.9 % of average leukocyte count | 2 | 50-59.9 % of average leukocyte count | 3 | 50% of average leukocyte count | 4 | Clinical Symptoms:<br>Anorexia | 3 | Diarrhea | 3 | Death | 20 | Treatment Groups | Animal ID | Score | Controls | 000 | 53 | 11-17 | 42 | 1-25 | 30 | 1-24 | 44 | 814 | 44 | 2-30 | 54 | 2-37 | 55 | 1-23 | 41 | 2-29 | 31 | 3-44 | 52 | 2-34 | 44 | 3-43 | 52 | Vaccinates | 818 | 13 | 805 | 11 |
|                                   | Response to Challenge                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Numerical Value (Point/day) |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
|                                   | Temperature Elevation:<br>Above 1.0°F                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 1                           |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
|                                   | Above 2.0°F                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 2                           |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
|                                   | Above 3.0°F                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 3                           |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
|                                   | Leukopenia:<br>80-100 % of average leukocyte count                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 0                           |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
|                                   | 70-79.9 % of average leukocyte count                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 1                           |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
|                                   | 60-69.9 % of average leukocyte count                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 2                           |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
|                                   | 50-59.9 % of average leukocyte count                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 3                           |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
|                                   | 50% of average leukocyte count                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 4                           |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
| Clinical Symptoms:<br>Anorexia    | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                             |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
| Diarrhea                          | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                             |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
| Death                             | 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                             |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
| Treatment Groups                  | Animal ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Score                       |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
| Controls                          | 000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 53                          |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
|                                   | 11-17                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 42                          |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
|                                   | 1-25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 30                          |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
|                                   | 1-24                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 44                          |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
|                                   | 814                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 44                          |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
|                                   | 2-30                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 54                          |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
|                                   | 2-37                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 55                          |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
|                                   | 1-23                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 41                          |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
|                                   | 2-29                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 31                          |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
|                                   | 3-44                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 52                          |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
|                                   | 2-34                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 44                          |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
|                                   | 3-43                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 52                          |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
| Vaccinates                        | 818                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 13                          |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |
|                                   | 805                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 11                          |                             |                                       |   |             |   |             |   |                                                    |   |                                      |   |                                      |   |                                      |   |                                |   |                                |   |          |   |       |    |                  |           |       |          |     |    |       |    |      |    |      |    |     |    |      |    |      |    |      |    |      |    |      |    |      |    |      |    |            |     |    |     |    |

|                    |            |                                     |    |  |
|--------------------|------------|-------------------------------------|----|--|
|                    |            | 008                                 | 25 |  |
|                    |            | 407                                 | 7  |  |
|                    |            | 108                                 | 21 |  |
|                    |            | 722                                 | 16 |  |
|                    |            | 727                                 | 6  |  |
|                    |            | 802                                 | 8  |  |
|                    |            | 314                                 | 19 |  |
|                    |            | 22                                  | 0  |  |
|                    |            | 71                                  | 19 |  |
|                    |            | 706                                 | 0  |  |
|                    |            | 750                                 | 11 |  |
|                    |            | 289                                 | 6  |  |
|                    |            | 66                                  | 3  |  |
|                    |            | 72                                  | 7  |  |
|                    |            | 701                                 | 13 |  |
|                    |            | 283                                 | 3  |  |
|                    |            | 137                                 | 9  |  |
|                    |            | 826                                 | 0  |  |
|                    |            | 717                                 | 20 |  |
|                    |            | 11                                  | 19 |  |
|                    |            | 93                                  | 10 |  |
|                    |            | 353                                 | 22 |  |
|                    |            | See next pages for individual data. |    |  |
| USDA Approval Date | 04/12/1984 |                                     |    |  |

# Rectal Temperatures in °F:

| TG         | ID    | Days of Study (Challenge was on Day 0) |       |       |       |       |       |       |       |       |       |       |       |       |       | Total Score |       |       |       |    |
|------------|-------|----------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------------|-------|-------|-------|----|
|            |       | -3                                     | -2    | -1    | 0     | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    |             | 11    | 12    | 13    | 14 |
| Controls   | 000   | 101.4                                  | 101.1 | 100.9 | 101.6 | 101.5 | 101.6 | 101.6 | 102.8 | 101.9 | 101.9 | 101.8 | 105.5 | 101.7 | 101.5 | 101.6       | 101.5 | 101.4 | 101.5 | 4  |
|            | 11-   | 100.9                                  | 100.8 | 101.2 | 100.6 | 101.2 | 101.2 | 101.1 | 101.8 | 101.8 | 101.4 | 103.7 | 103.3 | 101.9 | 101.9 | 101.5       | 102.0 | 101.5 | 101.7 | 5  |
|            | 17    |                                        |       |       |       |       |       |       |       |       |       |       |       |       |       |             |       |       |       |    |
|            | 1-25  | 101.5                                  | 101.4 | 101.6 | 101.7 | 101.5 | 101.5 | 102.6 | 102.3 | 101.6 | 101.7 | 104.2 | 101.8 | 102.7 | 101.8 | 101.8       | 101.9 | 101.1 | 102.3 | 3  |
|            | 1-24  | 101.9                                  | 101.2 | 101.4 | 101.4 | 101.2 | 100.9 | 102.3 | 102.0 | 102.5 | 103.8 | 106.2 | 1-2.8 | 101.9 | 103.4 | 102.2       | 102.4 | 101.7 | 102.1 | 8  |
|            | 814   | 101.4                                  | 101.5 | 101.4 | 101.3 | 101.7 | 101.5 | 103.2 | 101.8 | 102.3 | 101.7 | 104.4 | 102.3 | 101.9 | 102.4 | 102.4       | 102.2 | 102.0 | 101.3 | 6  |
|            | 2-30  | 101.6                                  | 101.8 | 101.2 | 102.0 | 101.7 | 101.9 | 102.6 | 102.0 | 101.8 | 101.9 | 104.4 | 104.4 | 101.6 | 101.8 | 101.8       | 101.9 | 101.6 | 101.9 | 5  |
|            | 2-37  | 101.5                                  | 101.2 | 101.5 | 101.4 | 101.4 | 102.4 | 102.2 | 103.3 | 103.4 | 102.8 | 105.9 | 103.5 | 102.9 | 102.7 | 102.2       | 102.2 | 101.1 | 102.7 | 13 |
|            | 1-23  | 101.6                                  | 101.5 | 101.6 | 101.7 | 101.7 | 101.7 | 102.3 | 102.2 | 102.0 | 102.7 | 103.8 | 102.9 | 102.0 | 102.8 | 102.1       | 101.8 | 101.8 | 102.0 | 5  |
|            | 2-29  | 101.3                                  | 101.6 | 101.8 | 101.2 | 101.4 | 101.6 | 102.7 | 101.8 | 101.8 | 102.5 | 103.7 | 104.9 | 102.0 | 101.6 | 101.8       | 101.9 | 101.6 | 101.9 | 5  |
|            | 3-44  | 100.8                                  | 100.9 | 101.4 | 101.6 | 101.6 | 104.1 | 103.9 | 102.8 | 103.0 | 102.9 | 105.4 | 104.1 | 103.1 | 102.0 | 102.3       | 102.3 | 101.7 | 102.1 | 15 |
|            | 2-34  | 101.8                                  | 101.7 | 101.2 | 101.0 | 101.2 | 101.5 | 102.6 | 102.6 | 101.8 | 102.3 | 105.0 | 103.9 | 102.9 | 102.1 | 102.0       | 101.5 | 101.8 | 102.9 | 8  |
|            | 3-43  | 101.2                                  | 101.0 | 101.6 | 100.8 | 100.8 | 101.4 | 102.4 | 102.2 | 102.4 | 102.3 | 105.7 | 102.4 | 102.8 | 102.1 | 101.4       | 101.6 | 100.9 | 102.1 | 8  |
| Vaccinates | 818   | 102.3                                  | 101.7 | 101.7 | 101.9 | 101.7 | 101.9 | 101.9 | 103.1 | 102.4 | 101.9 | 102.3 | 105.3 | 102.7 | 101.7 | 101.7       | 101.8 | 101.3 | 101.3 | 3  |
|            | 805   | 101.8                                  | 101.8 | 101.8 | 101.6 | 101.5 | 101.9 | 102.2 | 102.4 | 101.8 | 102.0 | 102.2 | 105.1 | 102.3 | 102.0 | 101.7       | 101.7 | 102.1 | 101.9 | 3  |
|            | 008   | 101.9                                  | 101.8 | 101.4 | 101.9 | 101.7 | 102.3 | 102.7 | 102.0 | 102.2 | 102.5 | 102.2 | 105.2 | 102.0 | 102.0 | 102.0       | 101.9 | 101.9 | 101.7 | 4  |
|            | 407   | 101.6                                  | 101.9 | 102.0 | 101.8 | 101.9 | 101.7 | 101.9 | 102.5 | 102.0 | 102.7 | 102.9 | 106.3 | 102.5 | 102.7 | 102.2       | 102.5 | 101.8 | 102.6 | 4  |
|            | 108   | 101.6                                  | 101.7 | 101.4 | 102.1 | 102.5 | 102.7 | 102.3 | 102.2 | 101.8 | 102.3 | 102.1 | 103.4 | 102.8 | 102.3 | 102.5       | 102.6 | 102.9 | 103.5 | 6  |
|            | 722   | 101.6                                  | 101.8 | 101.6 | 101.2 | 101.5 | 101.6 | 103.9 | 102.1 | 101.7 | 101.9 | 104.0 | 103.9 | 101.4 | 101.7 | 101.5       | 101.5 | 101.5 | 102.1 | 4  |
|            | 727   | 101.3                                  | 101.5 | 101.4 | 100.7 | 101.0 | 101.0 | 101.2 | 101.7 | 101.3 | 102.0 | 102.5 | 104.6 | 101.6 | 101.5 | 101.3       | 101.1 | 101.2 | 101.5 | 3  |
|            | 802   | 102.2                                  | 103.3 | 103.2 | 102.6 | 102.3 | 101.9 | 102.1 | 102.6 | 102.2 | 101.9 | 102.1 | 101.9 | 102.0 | 102.0 | 102.1       | 101.8 | 102.0 | 102.1 | 0  |
|            | 314   | 101.7                                  | 102.0 | 101.7 | 101.5 | 101.5 | 101.9 | 102.8 | 102.3 | 101.9 | 102.3 | 103.6 | 104.9 | 101.6 | 102.0 | 102.0       | 102.1 | 101.5 | 101.6 | 8  |
|            | 22    | 101.4                                  | 101.9 | 101.8 | 100.8 | 101.8 | 101.7 | 101.9 | 101.6 | 101.3 | 101.3 | 101.5 | 101.4 | 102.2 | 101.5 | 101.5       | 101.5 | 101.3 | 101.7 | 0  |
|            | 71    | 101.3                                  | 101.6 | 101.5 | 100.6 | 101.6 | 101.3 | 101.4 | 101.1 | 100.7 | 101.2 | 103.9 | 105.1 | 100.7 | 100.9 | 101.0       | 101.1 | 101.2 | 101.7 | 5  |
|            | 706   | 101.9                                  | 101.5 | 101.7 | 101.7 | 101.5 | 101.6 | 101.5 | 101.4 | 101.2 | 101.8 | 101.6 | 101.7 | 101.2 | 101.6 | 101.6       | 101.8 | 101.8 | 101.8 | 0  |
|            | 750   | 101.9                                  | 101.7 | 102.2 | 101.8 | 101.7 | 101.6 | 101.6 | 102.4 | 102.1 | 102.0 | 102.9 | 106.6 | 101.7 | 101.5 | 101.3       | 101.2 | 101.4 | 102.4 | 5  |
| 289        | 101.4 | 102.1                                  | 102.0 | 101.7 | 101.9 | 101.9 | 102.6 | 100.5 | 101.2 | 101.6 | 101.6 | 101.7 | 101.5 | 101.5 | 101.7 | 101.7       | 102.1 | 102.3 | 1     |    |
| 66         | 101.7 | 101.6                                  | 101.8 | 102.2 | 102.3 | 102.3 | 101.7 | 102.6 | 102.6 | 102.6 | 102.8 | 102.4 | 102.6 | 101.6 | 102.1 | 101.3       | 101.1 | 102.2 | 1     |    |
| 72         | 101.5 | 101.6                                  | 101.6 | 101.0 | 101.5 | 101.8 | 102.2 | 100.9 | 101.5 | 102.6 | 101.6 | 106.6 | 101.9 | 102.4 | 102.0 | 101.6       | 101.2 | 102.2 | 4     |    |
| 701        | 102.0 | 102.2                                  | 102.1 | 102.0 | 102.5 | 101.8 | 102.2 | 102.7 | 102.8 | 102.2 | 102.5 | 105.3 | 102.1 | 102.4 | 102.3 | 102.1       | 102.5 | 102.5 | 3     |    |
| 283        | 101.4 | 101.5                                  | 101.2 | 101.2 | 101.4 | 101.2 | 103.0 | 101.4 | 100.9 | 101.6 | 101.3 | 101.4 | 101.6 | 101.3 | 101.5 | 100.9       | 101.0 | 101.9 | 1     |    |
| 137        | 102.4 | 101.8                                  | 101.8 | 102.0 | 101.7 | 101.9 | 102.2 | 101.5 | 101.8 | 102.7 | 102.9 | 106.8 | 101.5 | 102.6 | 101.8 | 101.7       | 101.8 | 102.3 | 3     |    |
| 826        | 102.1 | 102.1                                  | 102.7 | 102.5 | 102.0 | 102.5 | 102.0 | 102.1 | 102.1 | 102.4 | 101.4 | 101.9 | 102.2 | 102.4 | 102.3 | 102.0       | 102.6 | 102.7 | 0     |    |
| 717        | 101.7 | 101.6                                  | 101.2 | 101.8 | 102.0 | 101.8 | 101.5 | 101.3 | 101.4 | 102.1 | 105.6 | 104.2 | 102.9 | 101.1 | 101.3 | 100.8       | 101.7 | 102.3 | 7     |    |
| 11         | 102.2 | 102.3                                  | 102.1 | 102.0 | 101.9 | 102.1 | 102.7 | 103.0 | 102.0 | 102.3 | 103.8 | 105.0 | 102.4 | 102.5 | 101.5 | 102.3       | 101.4 | 101.7 | 3     |    |
| 93         | 101.4 | 101.4                                  | 101.3 | 101.4 | 102.2 | 102.5 | 101.6 | 101.4 | 101.8 | 101.6 | 102.9 | 105.6 | 105.5 | 101.3 | 101.7 | 101.5       | 101.3 | 102.0 | 8     |    |
| 353        | 101.8 | 101.9                                  | 102.0 | 101.5 | 102.1 | 101.1 | 103.3 | 103.8 | 101.8 | 103.6 | 102.4 | 104.3 | 102.3 | 103.7 | 101.9 | 102.1       | 102.9 | 101.9 | 7     |    |

TG: Treatment group

White Blood Cell Count:

| TG         | ID   | Days of Study (Challenge was on Day 0) |       |       |       |       |       |       |       |       |       |       |       |       |       | Total Score |       |       |       |    |
|------------|------|----------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------------|-------|-------|-------|----|
|            |      | -3                                     | -2    | -1    | 0     | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    |             | 11    | 12    | 13    | 14 |
| Controls   | 000  | 12002                                  | 8034  | 7754  | 7920  | 8400  | 6516  | 4104  | 4549  | 5167  | 4858  | 5505  | 5428  | 7287  | 7269  | 7207        | 7671  | 7740  | 10106 | 28 |
|            | 11-  | 8838                                   | 6477  | 7061  | 7024  | 6702  | 5072  | 2879  | 3859  | 5306  | 5413  | 5076  | 6204  | 6648  | 7258  | 6869        | 7322  | 7828  | 6622  | 13 |
|            | 17   |                                        |       |       |       |       |       |       |       |       |       |       |       |       |       |             |       |       |       |    |
|            | 1-25 | 10967                                  | 8370  | 8437  | 9169  | 8835  | 6188  | 4057  | 5787  | 6546  | 5410  | 5769  | 7799  | 6700  | 7943  | 7744        | 7807  | 10991 | 8662  | 15 |
|            | 1-24 | 13093                                  | 10207 | 10401 | 11643 | 10534 | 8481  | 3931  | 7175  | 6447  | 5703  | 5792  | 8154  | 9924  | 10101 | 8733        | 9583  | 9264  | 10503 | 18 |
|            | 814  | 10108                                  | 11588 | 10373 | 10319 | 9129  | 7184  | 3921  | 7376  | 7525  | 6121  | 5555  | 7065  | 6752  | 8360  | 6211        | 11737 | 13341 | 11836 | 23 |
|            | 2-30 | 8928                                   | 9151  | 8136  | 6400  | 6844  | 5940  | 3489  | 4216  | 4548  | 3590  | 4621  | 5733  | 7630  | 7237  | 10041       | 6946  | 7942  | 7404  | 25 |
|            | 2-37 | 7577                                   | 6937  | 6703  | 8732  | 7657  | 4099  | 4787  | 4601  | 4008  | 4291  | 8916  | 5547  | 4990  | 5080  | 5342        | 5622  | 5105  | 8376  | 21 |
|            | 1-23 | 11045                                  | 8911  | 9128  | 9418  | 8804  | 6030  | 4424  | 4541  | 5776  | 6197  | 6116  | 7684  | 8948  | 8522  | 8188        | 10156 | 9713  | 9636  | 18 |
|            | 2-29 | 11360                                  | 9442  | 7192  | 9812  | 9087  | 8094  | 4327  | 4868  | 6408  | 5424  | 6398  | 6169  | 6892  | 7866  | 6837        | 10937 | 7141  | 8849  | 20 |
|            | 3-44 | 10671                                  | 10068 | 10140 | 9999  | 9358  | 6753  | 5436  | 7948  | 6603  | 6103  | 6478  | 9105  | 9434  | 7120  | 7408        | 10082 | 9201  | 9189  | 16 |
|            | 2-34 | 10025                                  | 8550  | 7199  | 9053  | 7597  | 6871  | 4002  | 5591  | 5422  | 4628  | 5372  | 15617 | 5957  | 6345  | 6310        | 8501  | 9497  | 12473 | 18 |
|            | 3-43 | 10714                                  | 9367  | 6812  | 7861  | 7210  | 4484  | 3982  | 4526  | 4446  | 2956  | 5536  | 8415  | 5367  | 5735  | 5102        | 6178  | 6322  | 8577  | 32 |
| Vaccinates | 818  | 9102                                   | 8300  | 7817  | 9705  | 9017  | 8499  | 8914  | 4926  | 6782  | 5610  | 5809  | 8118  | 13903 | 8069  | 8166        | 7112  | 7683  | 7623  | 7  |
|            | 805  | 9437                                   | 9136  | 8082  | 8561  | 9093  | 8144  | 8154  | 5512  | 5506  | 5514  | 6660  | 6460  | 8598  | 7181  | 7939        | 7828  | 8391  | 8375  | 8  |
|            | 008  | 10831                                  | 9151  | 9686  | 8914  | 6551  | 5988  | 7541  | 6470  | 5565  | 4837  | 5097  | 8159  | 9776  | 8975  | 7902        | 9765  | 8136  | 8569  | 18 |
|            | 407  | 9789                                   | 7940  | 8169  | 7974  | 9128  | 8413  | 8949  | 5686  | 7270  | 6649  | 6955  | 7310  | 11362 | 8658  | 8593        | 8354  | 7277  | 7682  | 3  |
|            | 108  | 7721                                   | 6963  | 7322  | 6424  | 6782  | 5764  | 7110  | 7469  | 4478  | 5390  | 7006  | 5155  | 7960  | 8293  | 10179       | 10369 | 8008  | 11273 | 5  |
|            | 722  | 9360                                   | 9489  | 8951  | 12250 | 9868  | 8575  | 5525  | 5738  | 6960  | 5103  | 5654  | 9658  | 7247  | 8637  | 7488        | 7848  | 7776  | 8230  | 12 |
|            | 727  | 9857                                   | 8528  | 8528  | 8054  | 9036  | 9316  | 7679  | 5989  | 8956  | 6082  | 6136  | 8045  | 9712  | 8069  | 8835        | 8345  | 7496  | 8847  | 3  |
|            | 802  | 10742                                  | 9516  | 9724  | 8484  | 7989  | 7981  | 7506  | 8428  | 8464  | 7393  | 8332  | 7551  | 7343  | 7928  | 8564        | 9419  | 7244  | 8117  | 8  |
|            | 314  | 11315                                  | 11871 | 12645 | 14417 | 12145 | 11813 | 7301  | 7103  | 8589  | 8199  | 7343  | 11835 | 11450 | 8916  | 13669       | 11776 | 10575 | 11405 | 11 |
|            | 22   | 12960                                  | 12446 | 11311 | 11367 | 12603 | 11010 | 11369 | 10563 | 10412 | 10719 | 12259 | 14051 | 12513 | 11141 | 12102       | 10350 | 9923  | 10106 | 0  |
|            | 71   | 8650                                   | 8197  | 7437  | 7889  | 8049  | 8966  | 7508  | 5522  | 5604  | 5116  | 5517  | 9407  | 11180 | 7182  | 7725        | 7009  | 6736  | 7769  | 8  |
|            | 706  | 8504                                   | 8488  | 8272  | 10548 | 8688  | 10540 | 8800  | 8514  | 8777  | 7740  | 7784  | 8869  | 9225  | 8216  | 8598        | 8866  | 7191  | 8457  | 0  |
|            | 750  | 9409                                   | 8073  | 5973  | 6995  | 7979  | 8681  | 7546  | 5103  | 5813  | 5988  | 5004  | 7383  | 11840 | 7922  | 8729        | 6119  | 6094  | 6363  | 6  |
|            | 289  | 6245                                   | 6740  | 6532  | 6661  | 7498  | 4895  | 4954  | 4927  | 5344  | 6310  | 5192  | 5964  | 5135  | 6010  | 6199        | 6139  | 6044  | 6059  | 5  |
|            | 66   | 8297                                   | 7876  | 6736  | 6325  | 5761  | 8465  | 10055 | 8821  | 6210  | 5669  | 6312  | 9291  | 10668 | 8908  | 8431        | 7081  | 7057  | 7968  | 2  |
|            | 72   | 7316                                   | 7794  | 5892  | 7900  | 8227  | 7624  | 8181  | 6016  | 6634  | 4523  | 4962  | 6288  | 10917 | 7884  | 8883        | 7460  | 7199  | 6722  | 3  |
|            | 701  | 8371                                   | 8610  | 8468  | 8015  | 8302  | 6760  | 6396  | 5237  | 7144  | 5475  | 5784  | 6622  | 10825 | 7844  | 7463        | 7175  | 6044  | 7675  | 10 |
|            | 283  | 9410                                   | 9721  | 7688  | 8774  | 9953  | 8223  | 8510  | 7661  | 7891  | 7109  | 6076  | 7642  | 9311  | 9993  | 12522       | 11661 | 10711 | 10990 | 2  |
|            | 137  | 10764                                  | 9534  | 8132  | 10768 | 10071 | 9124  | 8605  | 7509  | 7789  | 5716  | 6642  | 11805 | 13752 | 9840  | 9259        | 7023  | 7700  | 9006  | 6  |
|            | 826  | 6786                                   | 6526  | 6957  | 7615  | 6928  | 6401  | 6421  | 6508  | 8248  | 6374  | 6245  | 6861  | 6777  | 2077  | 6884        | 7612  | 6108  | 7106  | 0  |
|            | 717  | 10454                                  | 10440 | 9587  | 10495 | 8959  | 9594  | 6708  | 6173  | 7394  | 6524  | 5760  | 13417 | 11147 | 9638  | 8431        | 9051  | 10321 | 8686  | 10 |
|            | 11   | 11067                                  | 9278  | 8896  | 7499  | 7599  | 8227  | 5385  | 5088  | 5411  | 5115  | 5371  | 8191  | 8362  | 7681  | 7245        | 8143  | 7806  | 7463  | 16 |
|            | 93   | 10869                                  | 10007 | 8613  | 8974  | 9709  | 10072 | 9768  | 10636 | 10192 | 8189  | 6911  | 7423  | 10877 | 9286  | 10758       | 9684  | 8224  | 9049  | 2  |
|            | 353  | 10854                                  | 10816 | 9548  | 9960  | 9642  | 10373 | 7877  | 8236  | 8391  | 5155  | 5340  | 7187  | 10712 | 8079  | 7447        | 7559  | 9343  | 7042  | 15 |

TG: Treatment group

# Clinical Signs:

| Treatment Groups | Animal ID | Days Post-Challenge |   |   |   |   |    |    |    |    |    |    |    |    |    | Total Score |
|------------------|-----------|---------------------|---|---|---|---|----|----|----|----|----|----|----|----|----|-------------|
|                  |           | 1                   | 2 | 3 | 4 | 5 | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 |             |
| Controls         | 000       | N                   | N | N | A | D | D  | AD | A  | A  | N  | N  | N  | N  | N  | 21          |
|                  | 11-17     | N                   | N | N | A | D | AD | AD | A  | D  | N  | N  | N  | N  | N  | 24          |
|                  | 1-25      | N                   | N | N | N | N | N  | AD | D  | D  | N  | N  | N  | N  | N  | 12          |
|                  | 1-24      | N                   | N | N | N | A | D  | AD | AD | N  | N  | N  | N  | N  | N  | 18          |
|                  | 814       | N                   | N | N | N | A | N  | AD | A  | A  | N  | N  | N  | N  | N  | 15          |
|                  | 2-30      | N                   | N | N | A | A | D  | AD | AD | D  | N  | N  | N  | N  | N  | 24          |
|                  | 2-37      | N                   | N | N | A | N | AD | AD | A  | D  | N  | N  | N  | N  | N  | 21          |
|                  | 1-23      | N                   | N | N | N | N | D  | AD | AD | D  | N  | N  | N  | N  | N  | 18          |
|                  | 2-29      | N                   | N | N | N | N | D  | A  | A  | N  | N  | N  | N  | N  | N  | 6           |
|                  | 3-44      | N                   | N | N | N | D | N  | AD | AD | AD | N  | N  | N  | N  | N  | 21          |
|                  | 2-34      | N                   | N | N | N | N | N  | AD | AD | AD | N  | N  | N  | N  | N  | 18          |
|                  | 3-43      | N                   | N | N | N | N | N  | A  | A  | AD | N  | N  | N  | N  | N  | 12          |
| Vaccinates       | 818*      |                     |   |   |   |   |    |    |    |    |    |    |    |    |    | 3           |
|                  | 805       | N                   | N | N | N | N | N  | N  | N  | N  | N  | N  | N  | N  | N  | 0           |
|                  | 008*      |                     |   |   |   |   |    |    |    |    |    |    |    |    |    | 3           |
|                  | 407       | N                   | N | N | N | N | N  | N  | N  | N  | N  | N  | N  | N  | N  | 0           |
|                  | 108       | N                   | N | N | N | N | N  | N  | N  | N  | N  | N  | N  | N  | N  | 0           |
|                  | 722       | N                   | N | N | N | N | N  | N  | N  | N  | N  | N  | N  | N  | N  | 0           |
|                  | 727       | N                   | N | N | N | N | N  | N  | N  | N  | N  | N  | N  | N  | N  | 0           |
|                  | 802       | N                   | N | N | N | N | N  | N  | N  | N  | N  | N  | N  | N  | N  | 0           |
|                  | 314       | N                   | N | N | N | N | N  | N  | N  | N  | N  | N  | N  | N  | N  | 0           |
|                  | 22        | N                   | N | N | N | N | N  | N  | N  | N  | N  | N  | N  | N  | N  | 0           |
|                  | 71*       |                     |   |   |   |   |    |    |    |    |    |    |    |    |    | 6           |
|                  | 706       | N                   | N | N | N | N | N  | N  | N  | N  | N  | N  | N  | N  | N  | 0           |
|                  | 750       | N                   | N | N | N | N | N  | N  | N  | N  | N  | N  | N  | N  | N  | 0           |
|                  | 289       | N                   | N | N | N | N | N  | N  | N  | N  | N  | N  | N  | N  | N  | 0           |
|                  | 66        | N                   | N | N | N | N | N  | N  | N  | N  | N  | N  | N  | N  | N  | 0           |
|                  | 72        | N                   | N | N | N | N | N  | N  | N  | N  | N  | N  | N  | N  | N  | 0           |
|                  | 701       | N                   | N | N | N | N | N  | N  | N  | N  | N  | N  | N  | N  | N  | 0           |
|                  | 283       | N                   | N | N | N | N | N  | N  | N  | N  | N  | N  | N  | N  | N  | 0           |
|                  | 137       | N                   | N | N | N | N | N  | N  | N  | N  | N  | N  | N  | N  | N  | 0           |
|                  | 826       | N                   | N | N | N | N | N  | N  | N  | N  | N  | N  | N  | N  | N  | 0           |
|                  | 717*      |                     |   |   |   |   |    |    |    |    |    |    |    |    |    | 3           |
|                  | 11        | N                   | N | N | N | N | N  | N  | N  | N  | N  | N  | N  | N  | N  | 0           |
|                  | 93        | N                   | N | N | N | N | N  | N  | N  | N  | N  | N  | N  | N  | N  | 0           |
|                  | 353       | N                   | N | N | N | N | N  | N  | N  | N  | N  | N  | N  | N  | N  | 0           |

N: Normal

D: Diarrhea

A: Anorexia

\*: Missing data for individual days.

| Study Type                                                          | Efficacy                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
|---------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|-----------------------------|---------------------------------------------------------------------|---|-------------------------------------------|---|-------------------------------------------|---|---------------------------------------|---|---------------------------------|---|---------------------------------------|---|-------|----|------------------|-----------|-------|----------|------|----|------|----|------|----|------|----|------|----|------------|------|---|------|---|------|---|------|---|------|---|------|---|------|---|------|---|------|---|------|----|------|---|------|---|------|---|------|---|--------|----|
| Pertaining to                                                       | Herpes virus, Bovine [Infectious bovine rhinotracheitis (IBR) virus]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                       |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
| Study Purpose                                                       | Demonstrate efficacy against respiratory disease caused by infectious bovine rhinotracheitis (IBR) virus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
| Product Administration                                              | Two doses intramuscularly 21 days apart                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                       |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
| Study Animals                                                       | Twenty-nine (29) calves: 24 vaccinates and 5 controls; seronegative for IBR                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                       |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
| Challenge Description                                               | Virulent IBR 14 days after second dose of vaccine                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                       |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
| Interval observed after challenge                                   | Temperatures and clinical observations were recorded 2 days before challenge and continuing until 14 days after challenge.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                       |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
| Results                                                             | <div>A scoring system for evaluation of clinical responses as indices of severity of disease due to IBR virus infection was used:</div> <table><tr><th>Response to Challenge</th><th>Numerical Value (Point/day)</th></tr><tr><td>Temperature Elevation:<br/>≥ 1.0°F above average pre-challenge value</td><td>1</td></tr><tr><td>≥ 2.0°F above average pre-challenge value</td><td>2</td></tr><tr><td>≥ 3.0°F above average pre-challenge value</td><td>3</td></tr><tr><td>Clinical Symptoms:<br/>Nasal discharge</td><td>3</td></tr><tr><td>Ocular discharge/Conjunctivitis</td><td>3</td></tr><tr><td>Coughing/Audible rale/Heavy breathing</td><td>3</td></tr><tr><td>Death</td><td>20</td></tr></table> <div>Total Scores based on points/day:</div> <table><tr><th>Treatment Groups</th><th>Animal ID</th><th>Score</th></tr><tr><td rowspan="5">Controls</td><td>1419</td><td>30</td></tr><tr><td>1428</td><td>38</td></tr><tr><td>1455</td><td>67</td></tr><tr><td>1457</td><td>49</td></tr><tr><td>1474</td><td>56</td></tr><tr><td rowspan="15">Vaccinates</td><td>1324</td><td>1</td></tr><tr><td>1329</td><td>1</td></tr><tr><td>1332</td><td>1</td></tr><tr><td>1341</td><td>0</td></tr><tr><td>1345</td><td>0</td></tr><tr><td>1402</td><td>9</td></tr><tr><td>1405</td><td>1</td></tr><tr><td>1414</td><td>0</td></tr><tr><td>1415</td><td>0</td></tr><tr><td>1417</td><td>10</td></tr><tr><td>1421</td><td>0</td></tr><tr><td>1424</td><td>2</td></tr><tr><td>1426</td><td>1</td></tr><tr><td>1444</td><td>4</td></tr><tr><td>1446**</td><td>ND</td></tr></table> | Response to Challenge | Numerical Value (Point/day) | Temperature Elevation:<br>≥ 1.0°F above average pre-challenge value | 1 | ≥ 2.0°F above average pre-challenge value | 2 | ≥ 3.0°F above average pre-challenge value | 3 | Clinical Symptoms:<br>Nasal discharge | 3 | Ocular discharge/Conjunctivitis | 3 | Coughing/Audible rale/Heavy breathing | 3 | Death | 20 | Treatment Groups | Animal ID | Score | Controls | 1419 | 30 | 1428 | 38 | 1455 | 67 | 1457 | 49 | 1474 | 56 | Vaccinates | 1324 | 1 | 1329 | 1 | 1332 | 1 | 1341 | 0 | 1345 | 0 | 1402 | 9 | 1405 | 1 | 1414 | 0 | 1415 | 0 | 1417 | 10 | 1421 | 0 | 1424 | 2 | 1426 | 1 | 1444 | 4 | 1446** | ND |
| Response to Challenge                                               | Numerical Value (Point/day)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                       |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
| Temperature Elevation:<br>≥ 1.0°F above average pre-challenge value | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                       |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
| ≥ 2.0°F above average pre-challenge value                           | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                       |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
| ≥ 3.0°F above average pre-challenge value                           | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                       |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
| Clinical Symptoms:<br>Nasal discharge                               | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                       |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
| Ocular discharge/Conjunctivitis                                     | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                       |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
| Coughing/Audible rale/Heavy breathing                               | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                       |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
| Death                                                               | 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                       |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
| Treatment Groups                                                    | Animal ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Score                 |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
| Controls                                                            | 1419                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 30                    |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
|                                                                     | 1428                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 38                    |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
|                                                                     | 1455                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 67                    |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
|                                                                     | 1457                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 49                    |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
|                                                                     | 1474                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 56                    |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
| Vaccinates                                                          | 1324                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 1                     |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
|                                                                     | 1329                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 1                     |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
|                                                                     | 1332                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 1                     |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
|                                                                     | 1341                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 0                     |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
|                                                                     | 1345                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 0                     |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
|                                                                     | 1402                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 9                     |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
|                                                                     | 1405                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 1                     |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
|                                                                     | 1414                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 0                     |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
|                                                                     | 1415                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 0                     |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
|                                                                     | 1417                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 10                    |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
|                                                                     | 1421                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 0                     |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
|                                                                     | 1424                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 2                     |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
|                                                                     | 1426                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 1                     |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
|                                                                     | 1444                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 4                     |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |
|                                                                     | 1446**                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | ND                    |                             |                                                                     |   |                                           |   |                                           |   |                                       |   |                                 |   |                                       |   |       |    |                  |           |       |          |      |    |      |    |      |    |      |    |      |    |            |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |   |      |    |      |   |      |   |      |   |      |   |        |    |

|                                     |            |                                                          |   |
|-------------------------------------|------------|----------------------------------------------------------|---|
|                                     |            | 1447                                                     | 5 |
|                                     |            | 1448                                                     | 0 |
|                                     |            | 1458                                                     | 0 |
|                                     |            | 1464                                                     | 1 |
|                                     |            | 1468                                                     | 0 |
|                                     |            | 1473                                                     | 0 |
|                                     |            | 1476                                                     | 0 |
|                                     |            | 1479                                                     | 0 |
|                                     |            | 1480                                                     | 3 |
|                                     |            | **: Animal died from strangulation<br>ND: Not Determined |   |
| See next pages for individual data. |            |                                                          |   |
| USDA Approval Date                  | 06/24/1985 |                                                          |   |



# Rectal Temperatures in °F:

| Treatment Groups | Animal ID | Days of Study (Challenge was on Day 0) |       |       |       |       |       |       |       |       |       |       |       |       |       | Total Score |       |       |    |
|------------------|-----------|----------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------------|-------|-------|----|
|                  |           | -2                                     | -1    | 0     | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    | 11    |             | 12    | 13    | 14 |
| Controls         | 1419      | 101.4                                  | 101.8 | 101.6 | 101.5 | 101.7 | 102.7 | 104.2 | 104.3 | 102.6 | 101.1 | 100.9 | 101.1 | 101.4 | 101.4 | 102.0       | 101.5 | 101.6 | 6  |
|                  | 1428      | 102.1                                  | 101.6 | 102.0 | 102.2 | 104.0 | 106.0 | 106.0 | 105.3 | 105.4 | 103.4 | 102.6 | 102.5 | 102.5 | 102.6 | 102.4       | 102.3 | 102.4 | 17 |
|                  | 1455      | 102.2                                  | 102.6 | 102.6 | 102.0 | 102.9 | 104.3 | 106.5 | 106.2 | 105.5 | 104.3 | 104.5 | 102.7 | 101.7 | 101.6 | 101.2       | 101.8 | 101.7 | 13 |
|                  | 1457      | 101.7                                  | 101.9 | 102.2 | 102.0 | 102.7 | 105.7 | 106.2 | 105.6 | 105.3 | 104.2 | 104.8 | 103.8 | 103.4 | 102.9 | 102.6       | 102.6 | 101.9 | 19 |
|                  | 1474      | 102.1                                  | 102.3 | 102.2 | 101.5 | 101.9 | 103.4 | 105.6 | 106.5 | 106.0 | 105.1 | 104.7 | 102.7 | 101.8 | 102.1 | 101.7       | 101.6 | 101.5 | 14 |
|                  | 1324      | 102.7                                  | 102.1 | 101.9 | 101.9 | 101.8 | 101.9 | 102.0 | 104.1 | 102.5 | 102.3 | 101.6 | 101.7 | 101.7 | 101.3 | 102.0       | 102.0 | 102.3 | 1  |
|                  | 1329      | 101.9                                  | 101.8 | 101.3 | 101.7 | 101.9 | 103.6 | 102.0 | 102.6 | 102.4 | 101.4 | 101.3 | 101.8 | 101.9 | 102.1 | 102.1       | 102.4 | 102.3 | 1  |
|                  | 1332      | 101.8                                  | 101.9 | 101.2 | 101.5 | 102.2 | 103.4 | 102.4 | 102.6 | 101.6 | 101.3 | 101.4 | 101.5 | 101.6 | 101.6 | 101.7       | 101.9 | 101.5 | 1  |
| Vaccinates       | 1341      | 101.8                                  | 101.7 | 101.5 | 102.0 | 102.0 | 101.8 | 102.0 | 101.2 | 102.1 | 101.8 | 101.6 | 101.6 | 101.7 | 101.6 | 101.8       | 102.0 | 101.6 | 0  |
|                  | 1345      | 101.8                                  | 101.6 | 101.5 | 101.8 | 101.6 | 101.5 | 101.4 | 101.8 | 101.9 | 101.4 | 101.6 | 101.5 | 101.4 | 101.4 | 102.0       | 101.8 | 101.9 | 0  |
|                  | 1402      | 101.9                                  | 101.6 | 101.2 | 101.9 | 101.8 | 103.1 | 104.0 | 104.5 | 103.1 | 102.3 | 101.8 | 101.7 | 101.5 | 101.8 | 101.7       | 102.2 | 102.0 | 6  |
|                  | 1405      | 101.7                                  | 101.3 | 101.6 | 101.6 | 102.0 | 102.5 | 102.4 | 101.7 | 101.7 | 101.5 | 101.2 | 101.6 | 101.4 | 101.5 | 102.0       | 101.5 | 101.6 | 1  |
|                  | 1414      | 101.9                                  | 101.8 | 101.9 | 101.4 | 101.9 | 101.7 | 102.2 | 101.7 | 102.1 | 101.7 | 101.9 | 101.7 | 101.8 | 101.7 | 101.9       | 102.0 | 101.7 | 0  |
|                  | 1415      | 102.0                                  | 102.1 | 102.2 | 101.9 | 102.3 | 102.5 | 102.7 | 102.2 | 102.2 | 102.1 | 101.9 | 101.7 | 102.1 | 101.7 | 102.2       | 102.1 | 101.9 | 0  |
|                  | 1417      | 102.1                                  | 101.7 | 101.6 | 101.4 | 103.5 | 104.7 | 103.7 | 103.8 | 103.8 | 102.7 | 102.1 | 102.0 | 101.9 | 102.0 | 103.8       | 102.1 | 102.0 | 7  |
|                  | 1421      | 101.8                                  | 101.5 | 101.1 | 101.1 | 101.6 | 101.7 | 101.5 | 102.0 | 101.9 | 101.5 | 101.6 | 101.1 | 101.2 | 101.5 | 101.7       | 101.4 | 101.2 | 0  |
|                  | 1424      | 101.8                                  | 101.6 | 101.5 | 101.5 | 101.7 | 103.0 | 102.6 | 103.3 | 101.8 | 101.7 | 101.7 | 101.6 | 101.7 | 102.0 | 101.7       | 101.9 | 101.6 | 2  |
|                  | 1426      | 101.9                                  | 101.8 | 101.5 | 101.4 | 101.7 | 102.6 | 102.7 | 103.0 | 102.5 | 102.0 | 101.8 | 101.7 | 102.3 | 102.3 | 102.3       | 102.0 | 102.0 | 1  |
|                  | 1444      | 101.5                                  | 101.9 | 101.8 | 101.5 | 101.9 | 102.3 | 102.4 | 102.7 | 102.4 | 101.8 | 101.9 | 101.6 | 102.0 | 102.0 | 102.5       | 103.1 | 103.8 | 4  |
|                  | 1446*     | 101.6                                  | 101.5 | 101.6 | 101.8 | 101.7 | 102.2 | 102.0 | 102.0 | -     | -     | -     | -     | -     | -     | -           | -     | -     | -  |
|                  | 1447      | 101.6                                  | 101.5 | 101.5 | 101.5 | 102.6 | 103.6 | 103.2 | 103.2 | 101.6 | 101.7 | 101.6 | 101.5 | 101.7 | 101.5 | 101.5       | 101.7 | 101.7 | 5  |
|                  | 1448      | 101.7                                  | 101.7 | 101.6 | 101.5 | 101.4 | 101.2 | 102.3 | 102.2 | 102.0 | 101.4 | 101.3 | 101.3 | 101.6 | 101.6 | 102.2       | 101.9 | 101.9 | 0  |
|                  | 1458      | 101.5                                  | 101.8 | 101.7 | 101.5 | 101.9 | 101.9 | 102.4 | 102.3 | 101.9 | 101.5 | 101.6 | 101.6 | 101.7 | 101.9 | 101.9       | 101.9 | 101.9 | 0  |
|                  | 1464      | 102.5                                  | 101.9 | 101.8 | 101.9 | 101.9 | 102.9 | 102.3 | 102.6 | 102.5 | 102.0 | 101.9 | 101.8 | 101.8 | 101.9 | 101.9       | 101.9 | 103.0 | 1  |
| 1468             | 101.3     | 102.3                                  | 101.1 | 101.2 | 101.8 | 101.7 | 101.8 | 102.0 | 101.6 | 101.9 | 101.4 | 101.3 | 101.4 | 101.4 | 101.6 | 101.4       | 101.8 | 0     |    |
| 1473             | 101.9     | 102.0                                  | 102.0 | 102.3 | 102.1 | 101.8 | 101.7 | 102.0 | 102.3 | 101.8 | 101.9 | 102.2 | 102.3 | 102.2 | 102.2 | 102.4       | 102.2 | 0     |    |
| 1476             | 101.6     | 101.5                                  | 101.5 | 101.4 | 101.8 | 102.3 | 101.7 | 101.9 | 102.2 | 101.2 | 101.7 | 101.6 | 102.0 | 102.0 | 102.0 | 102.1       | 101.6 | 0     |    |
| 1479             | 102.0     | 101.7                                  | 101.9 | 101.7 | 102.0 | 102.1 | 102.6 | 102.2 | 102.2 | 101.6 | 101.3 | 101.5 | 101.7 | 101.4 | 101.1 | 102.1       | 101.7 | 0     |    |
| 1480             | 101.8     | 101.7                                  | 102.1 | 101.9 | 102.0 | 103.0 | 102.7 | 103.2 | 102.2 | 102.0 | 101.9 | 101.8 | 101.9 | 101.8 | 101.8 | 102.6       | 102.8 | 3     |    |

\*: Animal died from strangulation  
 -: Not Determined

# Clinical Signs of IBR Virus infection:

| Treatment Groups | Animal ID | Days Post-Challenge |    |          |                |                |          |          |          |          |    |    |    |    |    | Total Score |
|------------------|-----------|---------------------|----|----------|----------------|----------------|----------|----------|----------|----------|----|----|----|----|----|-------------|
|                  |           | 1                   | 2  | 3        | 4              | 5              | 6        | 7        | 8        | 9        | 10 | 11 | 12 | 13 | 14 |             |
| Controls         | 1419      | N                   | N  | ND       | OD<br>ND       | OD<br>ND*      | ND       | ND       | ND       | N        | N  | N  | N  | N  | N  | 24          |
|                  | 1428      | N                   | ND | ND       | ND             | N              | N        | OD<br>ND | OD       | OD       | N  | N  | N  | N  | N  | 21          |
|                  | 1455      | N                   | ND | ND       | OD<br>ND<br>HB | OD<br>ND<br>HB | ND<br>HB | ND<br>HB | ND<br>HB | ND<br>HB | ND | ND | N  | N  | N  | 54          |
|                  | 1457      | N                   | N  | OD       | OD             | OD<br>ND       | OD<br>ND | OD<br>ND | OD<br>ND | N        | N  | N  | N  | N  | N  | 30          |
|                  | 1474      | N                   | ND | OD<br>ND | ND             | OD<br>ND       | ND       | OD<br>ND | OD       | OD<br>ND | OD | OD | N  | N  | N  | 42          |
| Vaccinates       | 1324      | N                   | N  | N        | N              | N              | N        | N        | N        | N        | N  | N  | N  | N  | N  | 0           |
|                  | 1329      | N                   | N  | N        | N              | N              | N        | N        | N        | N        | N  | N  | N  | N  | N  | 0           |
|                  | 1332      | N                   | N  | N        | N              | N              | N        | N        | N        | N        | N  | N  | N  | N  | N  | 0           |
|                  | 1341      | N                   | N  | N        | N              | N              | N        | N        | N        | N        | N  | N  | N  | N  | N  | 0           |
|                  | 1345      | N                   | N  | N        | N              | N              | N        | N        | N        | N        | N  | N  | N  | N  | N  | 0           |
|                  | 1402      | N                   | N  | N        | ND             | N              | N        | N        | N        | N        | N  | N  | N  | N  | N  | 3           |
|                  | 1405      | N                   | N  | N        | N              | N              | N        | N        | N        | N        | N  | N  | N  | N  | N  | 0           |
|                  | 1414      | N                   | N  | N        | N              | N              | N        | N        | N        | N        | N  | N  | N  | N  | N  | 0           |
|                  | 1415      | N                   | N  | N        | N              | N              | N        | N        | N        | N        | N  | N  | N  | N  | N  | 0           |
|                  | 1417      | N                   | N  | N        | OD             | N              | N        | N        | N        | N        | N  | N  | N  | N  | N  | 3           |
|                  | 1421      | N                   | N  | N        | N              | N              | N        | N        | N        | N        | N  | N  | N  | N  | N  | 0           |
|                  | 1424      | N                   | N  | N        | N              | N              | N        | N        | N        | N        | N  | N  | N  | N  | N  | 0           |
|                  | 1426      | N                   | N  | N        | N              | N              | N        | N        | N        | N        | N  | N  | N  | N  | N  | 0           |
|                  | 1444      | N                   | N  | N        | N              | N              | N        | N        | N        | N        | N  | N  | N  | N  | N  | 0           |
|                  | 1446**    | N                   | N  | N        | N              | N              | -        | -        | -        | -        | -  | -  | -  | -  | -  | -           |
|                  | 1447      | N                   | N  | N        | N              | N              | N        | N        | N        | N        | N  | N  | N  | N  | N  | 0           |
|                  | 1448      | N                   | N  | N        | N              | N              | N        | N        | N        | N        | N  | N  | N  | N  | N  | 0           |
|                  | 1458      | N                   | N  | N        | N              | N              | N        | N        | N        | N        | N  | N  | N  | N  | N  | 0           |
|                  | 1464      | N                   | N  | N        | N              | N              | N        | N        | N        | N        | N  | N  | N  | N  | N  | 0           |
|                  | 1468      | N                   | N  | N        | N              | N              | N        | N        | N        | N        | N  | N  | N  | N  | N  | 0           |
|                  | 1473      | N                   | N  | N        | N              | N              | N        | N        | N        | N        | N  | N  | N  | N  | N  | 0           |
|                  | 1476      | N                   | N  | N        | N              | N              | N        | N        | N        | N        | N  | N  | N  | N  | N  | 0           |
|                  | 1479      | N                   | N  | N        | N              | N              | N        | N        | N        | N        | N  | N  | N  | N  | N  | 0           |
|                  | 1480      | N                   | N  | N        | N              | N              | N        | N        | N        | N        | N  | N  | N  | N  | N  | 0           |

N: No visible signs of IBR virus infection

ND: Nasal Discharge

OD: Ocular discharge/lacrimation/conjunctivitis

HB: Heavy/labored breathing or audible rale

\*: ND (blood)

\*\*: Animal died from strangulation

-: Not Determined

Serum-neutralizing Antibodies against IBR Virus Following Vaccination and Challenge:

| Treatment Groups  | Animal ID | Serum-neutralizing Antibodies Titers <sup>1</sup><br>Days Post-Vaccination |        |        |                 |
|-------------------|-----------|----------------------------------------------------------------------------|--------|--------|-----------------|
|                   |           | Day 0                                                                      | Day 21 | Day 35 | Day 49          |
| <b>Controls</b>   | 1419      | <2                                                                         | <2     | <2     | 32              |
|                   | 1428      | <2                                                                         | <2     | <2     | 90              |
|                   | 1455      | <2                                                                         | <2     | <2     | 256             |
|                   | 1457      | <2                                                                         | <2     | <2     | 90              |
|                   | 1474      | <2                                                                         | <2     | <2     | 182             |
| <b>Vaccinates</b> | 1324      | <2                                                                         | <2     | 9      | 256             |
|                   | 1329      | <2                                                                         | <2     | 10     | 256             |
|                   | 1332      | <2                                                                         | <2     | 6      | 256             |
|                   | 1341      | <2                                                                         | 3      | 12     | 362             |
|                   | 1345      | <2                                                                         | <2     | 12     | 512             |
|                   | 1402      | <2                                                                         | <2     | <2     | 512             |
|                   | 1405      | <2                                                                         | <2     | 14     | 512             |
|                   | 1414      | <2                                                                         | <2     | 8      | 512             |
|                   | 1415      | <2                                                                         | <2     | 10     | 512             |
|                   | 1417      | <2                                                                         | <2     | 4      | 512             |
|                   | 1421      | <2                                                                         | 3      | 17     | 256             |
|                   | 1424      | <2                                                                         | <2     | 8      | 256             |
|                   | 1426      | <2                                                                         | <2     | 7      | 256             |
|                   | 1444      | <2                                                                         | <2     | 11     | 256             |
|                   | 1446      | <2                                                                         | <2     | 14     | ND <sup>2</sup> |
|                   | 1447      | <2                                                                         | <2     | <2     | 128             |
|                   | 1448      | <2                                                                         | 4      | 16     | 256             |
|                   | 1458      | <2                                                                         | <2     | 28     | 512             |
|                   | 1464      | <2                                                                         | <2     | 8      | 512             |
|                   | 1468      | <2                                                                         | <2     | 11     | 256             |
|                   | 1473      | <2                                                                         | <2     | 17     | 256             |
|                   | 1476      | <2                                                                         | <2     | 24     | 512             |
|                   | 1479      | <2                                                                         | <2     | 8      | 256             |
|                   | 1480      | <2                                                                         | <2     | 4      | 90              |

1: Serum-neutralizing antibody titers expressed as reciprocal of end-point dilution of serum

2: Not determined (ND) as the animal died from strangulation

| Study Type                        | Efficacy                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                  |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|-----------|------|----------|-------|---|--------|---|--------|---|--------|---|--------|----|----|---|----|---|----|----|------------|-------|---|-------|---|-------|---|-------|---|-------|---|---------|---|--------|---|--------|---|--------|---|--------|---|--------|---|--------|---|--------|---|--------|---|--------|---|---------|---|---------|---|--------|---|--------|---|--------|---|---------|---|--------|---|
| Pertaining to                     | Bovine Parainfluenza type 3 Virus (PI <sub>3</sub> )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                  |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
| Study Purpose                     | Demonstrate efficacy against respiratory disease caused by PI <sub>3</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                  |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
| Product Administration            | Two doses intramuscularly with a 21-day interval between the injections.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                  |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
| Study Animals                     | Thirty-three calves; 25 vaccinates and 8 controls. All controls were seronegative for PI <sub>3</sub> , 3 vaccinates had low to medium level of neutralizing antibodies.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                  |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
| Challenge Description             | PI <sub>3</sub> challenge 14 days post second vaccination                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                  |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
| Interval observed after challenge | Serum samples were collected on day 0 (first vaccination), day 8, day 21 (date of second vaccination), day 35, day 43 (8 days after challenge) and day 49 (14 days after challenge inoculation). Clinical observations, temperatures, and nasal swabs were collected daily for 14 days after challenge.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                  |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
| Results                           | <p><u>Summary of Number of post-challenge days with positive PI<sub>3</sub> virus isolation:</u></p> <table><tr><th>Treatment Groups</th><th>Animal ID</th><th>Days</th></tr><tr><td rowspan="8">Controls</td><td>Y96/8</td><td>8</td></tr><tr><td>Y427/9</td><td>9</td></tr><tr><td>Y98/10</td><td>6</td></tr><tr><td>Y17/14</td><td>8</td></tr><tr><td>Y20/16</td><td>11</td></tr><tr><td>51</td><td>7</td></tr><tr><td>57</td><td>6</td></tr><tr><td>58</td><td>11</td></tr><tr><td rowspan="22">Vaccinates</td><td>R82/1</td><td>4</td></tr><tr><td>Y22/3</td><td>5</td></tr><tr><td>183/4</td><td>5</td></tr><tr><td>Y19/5</td><td>5</td></tr><tr><td>Y94/6</td><td>3</td></tr><tr><td>Y426/15</td><td>5</td></tr><tr><td>R86/17</td><td>5</td></tr><tr><td>Y23/22</td><td>5</td></tr><tr><td>Y93/32</td><td>5</td></tr><tr><td>Y97/36</td><td>7</td></tr><tr><td>R77/18</td><td>5</td></tr><tr><td>R78/19</td><td>5</td></tr><tr><td>R90/20</td><td>3</td></tr><tr><td>R85/21</td><td>1</td></tr><tr><td>R91/38</td><td>0</td></tr><tr><td>Y425/12</td><td>5</td></tr><tr><td>Y424/23</td><td>5</td></tr><tr><td>Y15/25</td><td>5</td></tr><tr><td>182/26</td><td>0</td></tr><tr><td>184/27</td><td>4</td></tr><tr><td>Y428/28</td><td>5</td></tr><tr><td>Y95/33</td><td>4</td></tr></table> | Treatment Groups | Animal ID | Days | Controls | Y96/8 | 8 | Y427/9 | 9 | Y98/10 | 6 | Y17/14 | 8 | Y20/16 | 11 | 51 | 7 | 57 | 6 | 58 | 11 | Vaccinates | R82/1 | 4 | Y22/3 | 5 | 183/4 | 5 | Y19/5 | 5 | Y94/6 | 3 | Y426/15 | 5 | R86/17 | 5 | Y23/22 | 5 | Y93/32 | 5 | Y97/36 | 7 | R77/18 | 5 | R78/19 | 5 | R90/20 | 3 | R85/21 | 1 | R91/38 | 0 | Y425/12 | 5 | Y424/23 | 5 | Y15/25 | 5 | 182/26 | 0 | 184/27 | 4 | Y428/28 | 5 | Y95/33 | 4 |
| Treatment Groups                  | Animal ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Days             |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
| Controls                          | Y96/8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 8                |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
|                                   | Y427/9                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 9                |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
|                                   | Y98/10                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 6                |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
|                                   | Y17/14                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 8                |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
|                                   | Y20/16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 11               |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
|                                   | 51                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 7                |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
|                                   | 57                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 6                |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
|                                   | 58                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 11               |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
| Vaccinates                        | R82/1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 4                |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
|                                   | Y22/3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 5                |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
|                                   | 183/4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 5                |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
|                                   | Y19/5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 5                |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
|                                   | Y94/6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 3                |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
|                                   | Y426/15                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 5                |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
|                                   | R86/17                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 5                |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
|                                   | Y23/22                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 5                |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
|                                   | Y93/32                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 5                |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
|                                   | Y97/36                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 7                |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
|                                   | R77/18                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 5                |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
|                                   | R78/19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 5                |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
|                                   | R90/20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 3                |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
|                                   | R85/21                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 1                |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
|                                   | R91/38                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 0                |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
|                                   | Y425/12                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 5                |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
|                                   | Y424/23                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 5                |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
|                                   | Y15/25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 5                |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
|                                   | 182/26                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 0                |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
|                                   | 184/27                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 4                |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
|                                   | Y428/28                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 5                |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |
|                                   | Y95/33                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 4                |           |      |          |       |   |        |   |        |   |        |   |        |    |    |   |    |   |    |    |            |       |   |       |   |       |   |       |   |       |   |         |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |        |   |         |   |         |   |        |   |        |   |        |   |         |   |        |   |

|                    |                                         |        |   |
|--------------------|-----------------------------------------|--------|---|
|                    |                                         | Y18/34 | 0 |
|                    |                                         | R83/35 | 0 |
|                    |                                         | Y16/37 | 4 |
|                    | See Individual data in the next tables. |        |   |
| USDA Approval Date | 03/10/1986                              |        |   |

Serological Response of Calves:

| Treatment Groups | Animal ID | Sero-neutralizing Titers* on Days of Study (Day 0 is Day of First Vaccination, Day 35 is Day of Challenge) |     |     |     |      |
|------------------|-----------|------------------------------------------------------------------------------------------------------------|-----|-----|-----|------|
|                  |           | 0                                                                                                          | 8   | 21  | 35  | 49   |
| Controls         | Y96/8     | < 2                                                                                                        | < 2 | < 2 | < 2 | 512  |
|                  | Y427/9    | < 2                                                                                                        | < 2 | < 2 | < 2 | 128  |
|                  | Y98/10    | < 2                                                                                                        | < 2 | < 2 | < 2 | 384  |
|                  | Y17/14    | < 2                                                                                                        | < 2 | < 2 | < 2 | 96   |
|                  | Y20/16    | < 2                                                                                                        | < 2 | < 2 | < 2 | 192  |
|                  | 51        | < 2                                                                                                        | < 2 | < 2 | < 2 | 24   |
|                  | 57        | < 2                                                                                                        | < 2 | < 2 | < 2 | 384  |
|                  | 58        | < 2                                                                                                        | < 2 | < 2 | < 2 | 256  |
| Vaccinates       | R82/1     | < 2                                                                                                        | < 2 | 6   | 48  | 3072 |
|                  | Y22/3     | < 2                                                                                                        | < 2 | 12  | 48  | 3072 |
|                  | 183/4     | < 2                                                                                                        | < 2 | 4   | 24  | 1536 |
|                  | Y19/5     | < 2                                                                                                        | < 2 | 12  | 16  | 2048 |
|                  | Y94/6     | < 2                                                                                                        | < 2 | < 2 | 16  | 768  |
|                  | Y426/15   | < 2                                                                                                        | < 2 | 4   | 24  | 768  |
|                  | R86/17    | 2                                                                                                          | 2   | 12  | 24  | 1536 |
|                  | Y23/22    | < 2                                                                                                        | < 2 | 12  | 32  | 1536 |
|                  | Y93/32    | < 2                                                                                                        | < 2 | < 2 | 8   | 768  |
|                  | Y97/36    | < 2                                                                                                        | < 2 | < 2 | 12  | 768  |
|                  | R77/18    | < 2                                                                                                        | < 2 | 12  | 48  | 1536 |
|                  | R78/19    | < 2                                                                                                        | < 2 | 48  | 48  | 3072 |
|                  | R90/20    | < 2                                                                                                        | < 2 | 4   | 32  | 3072 |
|                  | R85/21    | < 2                                                                                                        | 2   | 32  | 96  | 2048 |
|                  | R91/38    | 24                                                                                                         | 192 | 192 | 192 | 768  |
|                  | Y425/12   | < 2                                                                                                        | < 2 | 4   | 12  | 1024 |
|                  | Y424/23   | < 2                                                                                                        | < 2 | 24  | 48  | 4096 |
|                  | Y15/25    | < 2                                                                                                        | < 2 | 64  | 48  | 4096 |
|                  | 182/26    | < 2                                                                                                        | 6   | 32  | 48  | 1536 |
|                  | 184/27    | < 2                                                                                                        | 2   | 48  | 16  | 1024 |
|                  | Y428/28   | < 2                                                                                                        | < 2 | 4   | 12  | 4096 |
|                  | Y95/33    | < 2                                                                                                        | < 2 | < 2 | 4   | 1024 |
|                  | Y18/34    | < 2                                                                                                        | < 2 | 32  | 256 | 3072 |
|                  | R83/35    | 3                                                                                                          | 256 | 192 | 192 | 256  |
|                  | Y16/37    | < 2                                                                                                        | < 2 | 24  | 48  | 1024 |

\*Titer < 2 is considered seronegative

Virus Isolation from Nasal Swabs Obtained Daily from the Day of Challenge to Day 14:

| Treatment Groups | Animal ID | Study Days post-Challenge |   |   |   |   |   |   |   |   |   |    |    |    |    |    |
|------------------|-----------|---------------------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|
|                  |           | 0                         | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| Controls         | Y96/8     | -                         | + | + | + | + | + | + | + | + | - | -  | -  | -  | -  | -  |
|                  | Y427/9    | -                         | + | + | + | + | + | + | + | + | + | -  | -  | -  | -  | -  |
|                  | Y98/10    | -                         | + | + | + | + | + | + | - | - | - | -  | -  | -  | -  | -  |
|                  | Y17/14    | -                         | + | + | + | + | + | + | + | + | - | -  | -  | -  | -  | -  |
|                  | Y20/16    | -                         | + | + | + | + | + | + | + | + | + | +  | +  | -  | -  | -  |
|                  | 51        | -                         | + | + | + | + | + | + | + | - | - | -  | -  | -  | -  | -  |
|                  | 57        | -                         | + | + | + | + | + | + | - | - | - | -  | -  | -  | -  | -  |
|                  | 58        | -                         | + | + | + | + | + | + | + | + | + | +  | +  | -  | -  | -  |
| Vaccinates       | R82/1     | -                         | - | + | + | + | + | - | - | - | - | -  | -  | -  | -  | -  |
|                  | Y22/3     | -                         | + | + | + | + | + | - | - | - | - | -  | -  | -  | -  | -  |
|                  | 183/4     | -                         | + | + | + | + | + | - | - | - | - | -  | -  | -  | -  | -  |
|                  | Y19/5     | -                         | + | + | + | + | + | - | - | - | - | -  | -  | -  | -  | -  |
|                  | Y94/6     | -                         | - | - | + | + | + | - | - | - | - | -  | -  | -  | -  | -  |
|                  | Y426/15   | -                         | + | + | + | + | + | - | - | - | - | -  | -  | -  | -  | -  |
|                  | R86/17    | -                         | + | + | + | + | + | - | - | - | - | -  | -  | -  | -  | -  |
|                  | Y23/22    | -                         | + | + | + | + | + | - | - | - | - | -  | -  | -  | -  | -  |
|                  | Y93/32    | -                         | + | + | + | + | + | - | - | - | - | -  | -  | -  | -  | -  |
|                  | Y97/36    | -                         | + | + | + | + | + | + | + | - | - | -  | -  | -  | -  | -  |
|                  | R77/18    | -                         | + | + | + | + | + | - | - | - | - | -  | -  | -  | -  | -  |
|                  | R78/19    | -                         | + | + | + | + | + | - | - | - | - | -  | -  | -  | -  | -  |
|                  | R90/20    | -                         | + | + | + | - | - | - | - | - | - | -  | -  | -  | -  | -  |
|                  | R85/21    | -                         | + | - | - | - | - | - | - | - | - | -  | -  | -  | -  | -  |
|                  | R91/38    | -                         | - | - | - | - | - | - | - | - | - | -  | -  | -  | -  | -  |
|                  | Y425/12   | -                         | + | + | + | + | + | - | - | - | - | -  | -  | -  | -  | -  |
|                  | Y424/23   | -                         | + | + | + | + | + | - | - | - | - | -  | -  | -  | -  | -  |
|                  | Y15/25    | -                         | + | + | + | + | + | - | - | - | - | -  | -  | -  | -  | -  |
|                  | 182/26    | -                         | - | - | - | - | - | - | - | - | - | -  | -  | -  | -  | -  |
|                  | 184/27    | -                         | + | + | + | + | - | - | - | - | - | -  | -  | -  | -  | -  |
|                  | Y428/28   | -                         | + | + | + | + | + | - | - | - | - | -  | -  | -  | -  | -  |
|                  | Y95/33    | -                         | + | + | + | + | - | - | - | - | - | -  | -  | -  | -  | -  |
|                  | Y18/34    | -                         | - | - | - | - | - | - | - | - | - | -  | -  | -  | -  | -  |
|                  | R83/35    | -                         | - | - | - | - | - | - | - | - | - | -  | -  | -  | -  | -  |
|                  | Y16/37    | -                         | + | + | + | + | - | - | - | - | - | -  | -  | -  | -  | -  |

+: Virus was isolated; -: Virus was not isolated

Rectal Temperatures in °F:

| Treatment Groups | Animal ID  | Days of Study (Challenge was on Day 0) |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
|------------------|------------|----------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|                  |            | -2                                     | -1    | 0     | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    | 11    | 12    | 13    | 14    |       |
| Controls         | Y96/8      | 101.5                                  | 101.8 | 101.4 | 102.0 | 102.0 | 102.3 | 102.4 | 102.9 | 102.6 | 101.9 | 105.6 | 103.2 | 104.3 | 102.7 | 103.3 | 102.1 | 102.8 |       |
|                  | Y427/9     | 101.9                                  | 101.7 | 101.9 | 102.0 | 102.5 | 102.5 | 102.1 | 102.6 | 102.7 | 102.8 | 102.5 | 102.6 | 105.5 | 102.2 | 101.9 | 102.4 | 102.5 |       |
|                  | Y98/10     | 101.8                                  | 101.6 | 101.1 | 101.5 | 102.5 | 102.3 | 102.9 | 102.8 | 102.7 | 103.0 | 103.5 | 105.5 | 102.3 | 102.6 | 102.2 | 102.3 | 102.6 |       |
|                  | Y17/14     | 102.0                                  | 101.5 | 101.3 | 101.1 | 101.2 | 101.8 | 102.3 | 101.5 | 101.8 | 101.8 | 101.4 | 102.2 | 105.1 | 101.2 | 102.5 | 101.6 | 102.1 |       |
|                  | Y20/16     | 101.8                                  | 102.5 | 102.0 | 101.8 | 102.4 | 102.4 | 102.0 | 102.5 | 103.1 | 101.8 | 102.5 | 103.9 | 102.8 | 102.0 | 101.7 | 102.4 | 102.1 |       |
|                  | 51         | 101.7                                  | 101.4 | 101.3 | 101.5 | 101.8 | 101.7 | 101.5 | 101.4 | 101.1 | 101.5 | 102.0 | 101.5 | 101.8 | 102.6 | 101.3 | 101.7 | 101.5 |       |
|                  | 57         | 102.5                                  | 102.8 | 102.1 | 102.0 | 102.7 | 102.1 | 102.8 | 102.6 | 102.3 | 102.6 | 102.2 | 102.3 | 102.1 | 103.3 | 102.5 | 102.4 | 102.6 |       |
|                  | 58         | 101.9                                  | 101.8 | 101.0 | 101.2 | 101.6 | 101.9 | 102.0 | 102.2 | 101.5 | 101.9 | 102.3 | 105.0 | 103.9 | 102.2 | 102.0 | 101.7 | 101.5 |       |
|                  | Vaccinates | R82/1                                  | 101.8 | 101.4 | 101.1 | 101.1 | 101.9 | 101.5 | 102.5 | 103.7 | 102.2 | 101.9 | 101.6 | 101.7 | 109.4 | 102.2 | 102.7 | 102.1 | 103.0 |
|                  |            | Y22/3                                  | 102.5 | 102.1 | 101.8 | 102.2 | 102.0 | 101.9 | 102.1 | 102.3 | 102.6 | 103.0 | 103.1 | 103.1 | 103.3 | 102.3 | 101.7 | 102.4 | 101.8 |
| 183/4            |            | 102.1                                  | 101.6 | 101.6 | 101.5 | 101.7 | 101.9 | 101.8 | 101.8 | 101.5 | 101.9 | 101.8 | 105.5 | 103.6 | 101.7 | 101.7 | 101.5 | 101.3 |       |
| Y19/5            |            | 101.8                                  | 101.8 | 101.6 | 101.9 | 101.9 | 102.2 | 101.5 | 101.2 | 101.8 | 102.3 | 103.2 | 102.2 | 102.3 | 101.6 | 102.1 | 102.0 | 101.4 |       |
| Y94/6            |            | 102.2                                  | 101.9 | 102.1 | 102.0 | 102.0 | 102.2 | 103.5 | 102.6 | 102.4 | 102.0 | 105.5 | 102.7 | 103.5 | 102.6 | 103.0 | 103.2 | 102.6 |       |
| Y426/15          |            | 102.5                                  | 102.0 | 101.8 | 101.7 | 101.9 | 102.1 | 101.8 | 102.2 | 102.3 | 102.6 | 102.1 | 105.6 | 101.5 | 101.9 | 102.3 | 102.1 | 101.8 |       |
| R86/17           |            | 101.6                                  | 101.4 | 101.3 | 101.3 | 102.0 | 101.6 | 101.5 | 102.0 | 101.3 | 102.1 | 102.1 | 105.6 | 102.2 | 102.5 | 101.9 | 101.2 | 101.3 |       |
| Y23/22           |            | 101.8                                  | 101.4 | 101.4 | 101.6 | 101.6 | 102.5 | 101.4 | 102.3 | 101.9 | 101.7 | 103.7 | 102.7 | 102.3 | 101.4 | 101.9 | 101.3 | 101.5 |       |
| Y93/32           |            | 101.2                                  | 100.7 | 101.1 | 101.2 | 102.6 | 101.7 | 101.1 | 102.0 | 102.1 | 101.8 | 102.0 | 104.3 | 102.5 | 101.7 | 101.7 | 101.4 | 102.1 |       |
| Y97/36           |            | 101.7                                  | 101.3 | 101.3 | 101.6 | 101.8 | 101.7 | 100.9 | 101.5 | 101.7 | 101.5 | 101.4 | 101.9 | 102.1 | 102.0 | 102.2 | 106.5 | 102.0 |       |
| R77/18           |            | 101.2                                  | 101.6 | 101.9 | 101.9 | 101.8 | 101.8 | 101.6 | 101.8 | 101.6 | 101.5 | 101.3 | 101.6 | 102.1 | 101.8 | 101.7 | 101.7 | 101.6 |       |
| R78/19           |            | 101.8                                  | 101.6 | 101.5 | 101.6 | 102.0 | 101.4 | 101.5 | 101.7 | 101.7 | 101.5 | 101.7 | 101.8 | 102.0 | 101.8 | 101.7 | 101.9 | 101.8 |       |
| R90/20           |            | 101.8                                  | 102.1 | 101.2 | 101.6 | 102.4 | 102.2 | 101.7 | 102.1 | 101.7 | 102.0 | 101.6 | 101.5 | 101.8 | 101.2 | 102.0 | 101.5 | 101.5 |       |
| R85/21           |            | 102.3                                  | 102.0 | 101.3 | 101.6 | 101.6 | 101.4 | 101.6 | 101.6 | 101.6 | 101.4 | 101.4 | 101.9 | 102.3 | 101.8 | 101.5 | 106.1 | 103.1 |       |
| R91/38           |            | 101.9                                  | 101.5 | 101.7 | 101.4 | 101.5 | 101.9 | 100.9 | 101.2 | 101.0 | 100.8 | 101.1 | 101.1 | 101.2 | 101.6 | 101.7 | 101.4 | 101.3 |       |
| Y425/12          |            | 102.2                                  | 101.8 | 101.6 | 101.4 | 102.1 | 101.9 | 101.5 | 101.8 | 101.5 | 101.5 | 101.1 | 101.5 | 101.4 | 101.3 | 101.2 | 100.9 | 101.5 |       |
| Y424/23          |            | 101.8                                  | 101.3 | 101.4 | 101.7 | 102.2 | 102.4 | 102.2 | 101.6 | 101.3 | 101.1 | 101.5 | 101.4 | 101.9 | 101.7 | 101.4 | 101.3 | 101.5 |       |
| Y15/25           |            | 101.6                                  | 101.3 | 101.1 | 101.6 | 101.6 | 101.7 | 101.4 | 101.7 | 101.5 | 101.8 | 101.5 | 101.4 | 101.7 | 101.5 | 101.5 | 102.0 | 101.6 |       |
| 182/26           | 102.1      | 101.9                                  | 101.3 | 101.2 | 101.8 | 101.7 | 102.2 | 101.6 | 101.0 | 101.8 | 101.8 | 101.3 | 101.5 | 101.8 | 101.8 | 101.5 | 101.8 |       |       |
| 184/27           | 101.7      | 101.4                                  | 102.4 | 101.5 | 101.8 | 101.8 | 101.5 | 101.5 | 101.2 | 101.7 | 101.2 | 101.4 | 102.1 | 102.3 | 102.2 | 102.8 | 102.2 |       |       |
| Y428/28          | 102.3      | 102.0                                  | 102.0 | 101.2 | 102.4 | 102.2 | 101.9 | 102.4 | 101.9 | 102.1 | 101.9 | 102.1 | 102.4 | 102.3 | 102.8 | 102.6 | 102.1 |       |       |
| Y95/33           | 101.9      | 101.4                                  | 100.9 | 101.6 | 102.3 | 102.1 | 101.5 | 101.3 | 101.3 | 101.9 | 101.3 | 101.3 | 101.5 | 101.9 | 101.3 | 101.5 | 101.3 |       |       |
| Y18/34           | 101.6      | 101.3                                  | 101.4 | 101.7 | 102.2 | 102.3 | 101.3 | 101.5 | 101.5 | 101.3 | 101.7 | 101.6 | 101.2 | 101.6 | 101.6 | 101.7 | 101.3 |       |       |
| R83/35           | 101.9      | 101.6                                  | 101.4 | 101.4 | 101.8 | 101.4 | 101.0 | 101.1 | 101.2 | 101.5 | 101.4 | 101.4 | 101.9 | 101.4 | 101.3 | 101.3 | 101.5 |       |       |
| Y16/37           | 101.5      | 101.2                                  | 101.1 | 101.2 | 102.6 | 101.6 | 101.4 | 101.4 | 101.6 | 101.4 | 101.8 | 101.8 | 101.5 | 101.4 | 101.6 | 101.7 | 101.5 |       |       |



Clinical Signs of PI<sub>3</sub> viral infection:

| Treatment Groups | Animal ID | Days Post-Challenge |   |   |   |   |    |    |    |     |     |    |    |    |    |
|------------------|-----------|---------------------|---|---|---|---|----|----|----|-----|-----|----|----|----|----|
|                  |           | 1                   | 2 | 3 | 4 | 5 | 6  | 7  | 8  | 9   | 10  | 11 | 12 | 13 | 14 |
| Controls         | Y96/8     | N                   | N | N | N | N | N  | N  | N  | N   | N   | N  | N  | N  | N  |
|                  | Y427/9    | N                   | N | N | N | N | N  | N  | N  | ND  | ND  | N  | N  | N  | N  |
|                  | Y98/10    | N                   | N | N | N | N | N  | N  | N  | N   | N   | N  | N  | N  | N  |
|                  | Y17/14    | N                   | N | N | N | N | N  | N  | N* | ND* | ND* | N  | N  | N  | N  |
|                  | Y20/16    | N                   | N | N | N | N | ND | ND | ND | ND  | N   | N  | N  | N  | N  |
|                  | 51        | N                   | N | N | N | N | N  | N  | N  | N   | N   | N  | N  | N  | N  |
|                  | 57        | N                   | N | N | N | N | N  | N  | N  | N   | N   | N  | N  | N  | N  |
|                  | 58        | N                   | N | N | N | N | N  | N  | N  | ND  | ND  | N  | N  | N  | N  |
| Vaccinates       | R82/1     | N                   | N | N | N | N | N  | N  | N  | N   | N   | N  | N  | N  | N  |
|                  | Y22/3     | N                   | N | N | N | N | N  | N  | N  | N   | N   | N  | N  | N  | N  |
|                  | 183/4     | N                   | N | N | N | N | N  | N  | N  | N   | N   | N  | N  | N  | N  |
|                  | Y19/5     | N                   | N | N | N | N | N  | N  | N  | N   | N   | N  | N  | N  | N  |
|                  | Y94/6     | N                   | N | N | N | N | N  | N  | N  | N   | N   | N  | N  | N  | N  |
|                  | Y426/15   | N                   | N | N | N | N | N  | N  | N  | N   | N   | N  | N  | N  | N  |
|                  | R86/17    | N                   | N | N | N | N | N  | N  | N  | N   | N   | N  | N  | N  | N  |
|                  | Y23/22    | N                   | N | N | N | N | N  | N  | N  | N   | N   | N  | N  | N  | N  |
|                  | Y93/32    | N                   | N | N | N | N | N  | N  | N  | N   | N   | N  | N  | N  | N  |
|                  | Y97/36    | N                   | N | N | N | N | N  | N  | N  | N   | N   | N  | N  | N  | N  |
|                  | R77/18    | N                   | N | N | N | N | N  | N  | N  | N   | N   | N  | N  | N  | N  |
|                  | R78/19    | N                   | N | N | N | N | N  | N  | N  | N   | N   | N  | N  | N  | N  |
|                  | R90/20    | N                   | N | N | N | N | N  | N  | N  | N   | N   | N  | N  | N  | N  |
|                  | R85/21    | N                   | N | N | N | N | N  | N  | N  | N   | N   | N  | N  | N  | N  |
|                  | R91/38    | N                   | N | N | N | N | N  | N  | N  | N   | N   | N  | N  | N  | N  |
|                  | Y425/12   | N                   | N | N | N | N | N  | N  | N  | N   | N   | N  | N  | N  | N  |
|                  | Y424/23   | N                   | N | N | N | N | N  | N  | N  | N   | N   | N  | N  | N  | N  |
|                  | Y15/25    | N                   | N | N | N | N | N  | N  | N  | N   | N   | N  | N  | N  | N  |
|                  | 182/26    | N                   | N | N | N | N | N  | N  | N  | N   | N   | N  | N  | N  | N  |
|                  | 184/27    | N                   | N | N | N | N | N  | N  | N  | N   | N   | N  | N  | N  | N  |
|                  | Y428/28   | N                   | N | N | N | N | N  | N  | N  | N   | N   | N  | N  | N  | N  |
|                  | Y95/33    | N                   | N | N | N | N | N  | N  | N  | N   | N   | N  | N  | N  | N  |
|                  | Y18/34    | N                   | N | N | N | N | N  | N  | N  | N   | N   | N  | N  | N  | N  |
|                  | R83/35    | N                   | N | N | N | N | N  | N  | N  | N   | N   | N  | N  | N  | N  |
|                  | Y16/37    | N                   | N | N | N | N | N  | N  | N  | N   | N   | N  | N  | N  | N  |

N: No visible signs of PI<sub>3</sub> virus infection

ND: Nasal Discharge

\*: Blood

|                                          |                                                                                                                                                                                                                                                                          |
|------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Study Type</b>                        | Efficacy                                                                                                                                                                                                                                                                 |
| <b>Pertaining to</b>                     | Bovine Respiratory Syncytial Virus (BRSV)                                                                                                                                                                                                                                |
| <b>Study Purpose</b>                     | Demonstrate efficacy against respiratory disease caused by BRSV                                                                                                                                                                                                          |
| <b>Product Administration</b>            | Two doses Intramuscularly with the second dose 3 weeks after the first dose                                                                                                                                                                                              |
| <b>Study Animals</b>                     | 32 calves; 24 vaccinates and 8 controls; Seronegative (<1:2) for BRSV.                                                                                                                                                                                                   |
| <b>Challenge Description</b>             | BRSV challenge 21 days after second vaccination                                                                                                                                                                                                                          |
| <b>Interval observed after challenge</b> | Nasal swabs samples were taken for 14 days post challenge for isolation. Clinical evaluations (depression, anorexia, coughing, sneezing, rhinorrhea, lacrimation, and respiratory distress) and temperature collections were conducted daily for 14 days post challenge. |
| <b>Results</b>                           | See individual data on next tables.                                                                                                                                                                                                                                      |
| <b>USDA Approval Date</b>                | 02/17/1983                                                                                                                                                                                                                                                               |

Isolation of Virus from Nasal Swabs Samples:

| Treatment Groups | Animal ID | Days Post-Challenge |   |   |   |   |   |   |   |   |    |    |    |    |    |
|------------------|-----------|---------------------|---|---|---|---|---|---|---|---|----|----|----|----|----|
|                  |           | 1                   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| Controls         | 166       | -                   | + | + | + | + | + | + | + | - | -  | -  | -  | -  | -  |
|                  | 176       | -                   | + | + | + | + | + | + | + | - | -  | -  | -  | -  | -  |
|                  | 180       | -                   | + | + | + | + | + | + | - | - | -  | -  | -  | -  | -  |
|                  | 186       | -                   | + | + | + | + | + | + | - | - | -  | -  | -  | -  | -  |
|                  | 192       | -                   | + | + | + | + | + | + | - | - | -  | -  | -  | -  | -  |
|                  | 198       | -                   | - | - | + | + | + | + | - | - | -  | -  | -  | -  | -  |
|                  | 206       | -                   | - | + | + | + | + | + | + | - | -  | -  | -  | -  | -  |
|                  | 207       | -                   | - | + | + | + | + | - | - | - | -  | -  | -  | -  | -  |
| Vaccinates       | 165       | -                   | - | - | - | + | - | - | - | - | -  | -  | -  | -  | -  |
|                  | 167       | -                   | - | + | + | + | + | - | - | - | -  | -  | -  | -  | -  |
|                  | 169       | -                   | - | + | + | + | + | - | - | - | -  | -  | -  | -  | -  |
|                  | 170       | -                   | - | + | + | + | - | - | - | - | -  | -  | -  | -  | -  |
|                  | 171       | -                   | - | + | + | + | + | - | - | - | -  | -  | -  | -  | -  |
|                  | 172       | -                   | - | + | + | + | - | - | - | - | -  | -  | -  | -  | -  |
|                  | 173       | -                   | - | + | + | + | + | - | - | - | -  | -  | -  | -  | -  |
|                  | 177       | -                   | - | + | + | + | + | - | - | - | -  | -  | -  | -  | -  |
|                  | 179       | -                   | - | + | + | + | + | - | - | - | -  | -  | -  | -  | -  |
|                  | 181       | -                   | - | + | + | + | + | - | - | - | -  | -  | -  | -  | -  |
|                  | 183       | -                   | - | + | + | + | + | - | - | - | -  | -  | -  | -  | -  |
|                  | 185       | -                   | - | + | + | + | + | + | - | - | -  | -  | -  | -  | -  |
|                  | 187       | -                   | - | + | + | + | + | - | - | - | -  | -  | -  | -  | -  |
|                  | 188       | -                   | - | + | + | + | + | - | - | - | -  | -  | -  | -  | -  |
|                  | 191       | -                   | + | + | + | + | + | - | - | - | -  | -  | -  | -  | -  |
|                  | 193       | -                   | - | + | + | + | + | - | - | - | -  | -  | -  | -  | -  |
|                  | 195       | -                   | - | + | + | + | + | - | - | - | -  | -  | -  | -  | -  |
|                  | 199       | -                   | - | + | + | + | + | - | - | - | -  | -  | -  | -  | -  |
|                  | 200       | -                   | - | + | + | + | + | - | - | - | -  | -  | -  | -  | -  |
|                  | 203       | -                   | - | + | + | + | + | - | - | - | -  | -  | -  | -  | -  |
|                  | 205       | -                   | - | + | + | + | + | - | - | - | -  | -  | -  | -  | -  |
|                  | 210       | -                   | - | - | + | + | - | - | - | - | -  | -  | -  | -  | -  |
|                  | 212       | -                   | - | + | + | + | - | - | - | - | -  | -  | -  | -  | -  |
|                  | 217       | -                   | - | - | - | - | - | - | - | - | -  | -  | -  | -  | -  |

# Temperatures:

| Treatment Groups | Animal ID | Study Days (Day 0 is challenge day) |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
|------------------|-----------|-------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|                  |           |                                     | -2    | -1    | 0     | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    | 11    | 12    | 13    | 14    |
| Controls         | 166       | AM                                  | 101.6 | 100.4 | 101.6 | 101.3 | 101.0 | 101.1 | 103.5 | 102.2 | 102.0 | 102.0 | 101.4 | 102.1 | 105.6 | 101.5 | 100.7 | 101.6 | 100.1 |
|                  |           | PM                                  |       |       | 102.0 | 101.0 | 101.8 | 101.2 | 102.5 | 101.6 | 102.0 | 101.4 | 102.7 | 101.9 | 104.3 | 101.7 | 102.1 | 101.7 | 101.2 |
|                  | 176       | AM                                  | 101.3 | 101.1 | 101.2 | 101.7 | 100.9 | 103.5 | 102.2 | 101.5 | 101.8 | 102.0 | 103.6 | 101.5 | 100.3 | 101.9 | 102.4 | 101.7 | 101.0 |
|                  |           | PM                                  |       |       | 101.0 | 102.0 | 101.5 | 102.3 | 101.3 | 101.7 | 102.6 | 102.0 | 102.8 | 102.2 | 100.5 | 102.8 | 102.2 | 101.8 | 102.1 |
|                  | 180       | AM                                  | 101.6 | 100.8 | 101.8 | 101.3 | 100.6 | 100.5 | 102.8 | 102.3 | 102.7 | 103.5 | 104.0 | 101.4 | 102.5 | 100.8 | 100.7 | 100.1 | 100.6 |
|                  |           | PM                                  |       |       | 102.6 | 101.6 | 100.6 | 101.2 | 103.6 | 101.1 | 102.9 | 102.2 | 105.0 | 102.2 | 102.0 | 100.7 | 100.2 | 100.0 | 101.0 |
|                  | 186       | AM                                  | 101.2 | 100.5 | 101.9 | 102.0 | 101.9 | 101.7 | 102.6 | 102.4 | 101.7 | 103.8 | 101.3 | 101.1 | 101.8 | 101.0 | 100.7 | 101.3 | 101.2 |
|                  |           | PM                                  |       |       | 102.0 | 101.8 | 102.0 | 101.3 | 103.2 | 101.4 | 101.2 | 102.1 | 100.2 | 101.4 | 102.5 | 101.0 | 101.0 | 101.7 | 101.7 |
|                  | 192       | AM                                  | 101.9 | 101.3 | 101.7 | 102.1 | 101.8 | 103.0 | 101.7 | 101.7 | 103.2 | 105.5 | 104.5 | 104.1 | 106.0 | 101.3 | 101.7 | 101.5 | 101.6 |
|                  |           | PM                                  |       |       | 101.6 | 101.8 | 101.2 | 103.1 | 101.2 | 101.1 | 105.3 | 105.5 | 104.1 | 103.7 | 102.8 | 101.6 | 102.3 | 101.4 | 101.5 |
| 198              | AM        | 101.5                               | 100.8 | 102.4 | 102.0 | 101.6 | 101.9 | 101.8 | 101.5 | 102.1 | 102.6 | 102.2 | 101.9 | 101.2 | 101.3 | 101.3 | 101.6 | 101.4 |       |
|                  | PM        |                                     |       | 102.2 | 102.4 | 101.9 | 101.4 | 101.4 | 101.4 | 101.1 | 101.3 | 101.3 | 102.0 | 101.5 | 100.4 | 100.9 | 101.9 | 100.8 |       |
| 206              | AM        | 102.5                               | 101.9 | 102.5 | 103.1 | 102.1 | 102.1 | 103.2 | 102.3 | 102.8 | 103.3 | 106.3 | 101.0 | 101.3 | 102.2 | 101.6 | 102.3 | 101.8 |       |
|                  | PM        |                                     |       | 102.6 | 103.0 | 101.8 | 103.5 | 102.0 | 101.4 | 103.9 | 103.3 | 103.4 | 102.4 | 103.7 | 102.3 | 101.6 | 102.4 | 101.4 |       |
| 207              | AM        | 101.0                               | 100.0 | 101.2 | 101.6 | 100.2 | 100.3 | 105.1 | 101.1 | 103.7 | 102.8 | 105.3 | 101.5 | 100.9 | 104.0 | 101.2 | 100.8 | 101.3 |       |
|                  | PM        |                                     |       | 101.0 | 102.2 | 101.0 | 102.0 | 101.9 | 100.2 | 101.3 | 104.8 | 105.3 | 103.4 | 103.5 | 103.2 | 101.0 | 101.1 | 100.9 |       |
| Vaccinates       | 165       | AM                                  | 98.7  | 98.8  | 102.1 | 102.2 | 100.5 | 99.7  | 100.7 | 101.0 | 100.9 | 101.6 | 101.4 | 100.6 | 101.0 | 98.9  | 99.8  | 100.5 | 101.0 |
|                  |           | PM                                  |       |       | 102.2 | 101.9 | 100.4 | 100.8 | 100.1 | 99.8  | 101.1 | 100.9 | 100.9 | 101.0 | 100.7 | 99.4  | 100.0 | 101.0 | 101.2 |
|                  | 167       | AM                                  | 100.8 | 101.0 | 101.5 | 101.8 | 101.2 | 101.6 | 101.7 | 101.5 | 102.4 | 101.9 | 101.6 | 101.4 | 101.7 | 100.3 | 101.0 | 101.2 | 101.6 |
|                  |           | PM                                  |       |       | 101.7 | 102.0 | 102.2 | 100.9 | 101.7 | 102.0 | 102.3 | 101.9 | 101.0 | 101.4 | 101.8 | 100.7 | 101.0 | 99.6  | 101.1 |
|                  | 169       | AM                                  | 100.0 | 100.3 | 101.2 | 102.0 | 101.7 | 101.7 | 102.0 | 101.9 | 101.7 | 102.2 | 103.5 | 104.9 | 102.4 | 102.2 | 102.1 | 102.4 | 102.1 |
|                  |           | PM                                  |       |       | 101.4 | 101.8 | 101.0 | 101.6 | 101.8 | 101.9 | 102.3 | 102.1 | 104.8 | 104.8 | 101.8 | 102.2 | 102.3 | 102.2 | 101.6 |
|                  | 170       | AM                                  | 100.4 | 100.7 | 102.0 | 101.8 | 102.1 | 101.8 | 101.4 | 101.5 | 100.8 | 101.6 | 101.6 | 102.8 | 101.2 | 100.3 | 100.4 | 101.3 | 101.3 |
|                  |           | PM                                  |       |       | 102.6 | 101.7 | 101.9 | 101.2 | 101.5 | 101.3 | 100.6 | 101.5 | 100.8 | 102.6 | 100.6 | 100.0 | 100.4 | 100.4 | 100.1 |
|                  | 171       | AM                                  | 99.4  | 100.8 | 101.5 | 102.1 | 101.6 | 100.8 | 101.2 | 101.0 | 101.2 | 101.4 | 101.5 | 103.2 | 100.7 | 100.4 | 100.3 | 100.6 | 100.5 |
|                  |           | PM                                  |       |       | 101.0 | 101.6 | 101.2 | 101.6 | 101.2 | 101.4 | 100.9 | 101.8 | 102.8 | 103.8 | 101.8 | 100.1 | 100.1 | 102.2 | 101.6 |
|                  | 172       | AM                                  | 100.6 | 100.4 | 101.4 | 102.1 | 101.6 | 101.5 | 102.0 | 102.1 | 101.0 | 101.6 | 105.4 | 101.3 | 100.7 | 99.3  | 99.6  | 101.1 | 100.9 |
|                  |           | PM                                  |       |       | 101.7 | 101.8 | 102.0 | 101.7 | 101.9 | 101.8 | 101.3 | 100.9 | 104.1 | 102.0 | 101.6 | 100.1 | 99.6  | 100.6 | 101.2 |
|                  | 173       | AM                                  | 98.9  | 100.1 | 101.6 | 102.0 | 101.6 | 101.2 | 101.1 | 101.5 | 101.3 | 103.6 | 101.5 | 102.3 | 103.2 | 101.6 | 101.3 | 100.9 | 100.8 |
|                  |           | PM                                  |       |       | 101.2 | 101.8 | 100.9 | 101.5 | 100.1 | 101.1 | 101.4 | 103.3 | 100.6 | 103.0 | 102.9 | 102.8 | 101.1 | 101.4 | 101.5 |
|                  | 177       | AM                                  | 101.0 | 102.6 | 102.8 | 102.7 | 102.7 | 101.8 | 102.6 | 102.8 | 102.4 | 102.7 | 103.5 | 102.8 | 101.8 | 100.4 | 101.3 | 101.3 | 101.6 |
|                  |           | PM                                  |       |       | 102.6 | 102.7 | 102.4 | 102.0 | 101.9 | 101.7 | 101.6 | 102.2 | 104.3 | 102.6 | 102.5 | 100.5 | 101.5 | 101.8 | 102.1 |
|                  | 179       | AM                                  | 100.4 | 100.2 | 101.3 | 102.7 | 100.7 | 101.2 | 101.4 | 102.0 | 102.9 | 102.4 | 101.8 | 104.0 | 101.3 | 100.8 | 99.9  | 100.0 | 101.5 |
|                  |           | PM                                  |       |       | 101.0 | 102.6 | 102.5 | 101.8 | 101.4 | 101.6 | 102.0 | 101.7 | 101.9 | 103.6 | 103.2 | 100.1 | 100.3 | 101.1 | 100.8 |
|                  | 181       | AM                                  | 100.3 | 100.4 | 101.7 | 102.0 | 101.5 | 101.5 | 103.3 | 101.7 | 102.0 | 101.8 | 101.4 | 102.6 | 101.4 | 102.2 | 102.5 | 100.8 | 101.6 |
|                  |           | PM                                  |       |       | 102.4 | 102.0 | 101.2 | 101.5 | 102.8 | 102.0 | 102.3 | 100.8 | 101.8 | 103.0 | 102.4 | 103.4 | 101.9 | 100.4 | 101.3 |
|                  | 183       | AM                                  | 100.5 | 101.1 | 101.0 | 101.4 | 101.9 | 101.4 | 101.5 | 101.4 | 101.2 | 102.8 | 101.6 | 101.3 | 102.2 | 101.2 | 100.5 | 100.6 | 100.6 |
|                  |           | PM                                  |       |       | 102.0 | 101.6 | 102.1 | 101.7 | 101.2 | 101.5 | 101.2 | 102.9 | 101.1 | 101.6 | 101.9 | 100.8 | 101.1 | 100.6 | 100.8 |
|                  | 185       | AM                                  | 101.0 | 101.7 | 102.2 | 102.3 | 101.7 | 100.7 | 104.3 | 103.4 | 102.8 | 101.7 | 102.0 | 102.2 | 102.1 | 101.3 | 101.4 | 101.9 | 101.7 |
|                  |           | PM                                  |       |       | 102.2 | 102.0 | 101.0 | 101.6 | 103.5 | 102.8 | 101.7 | 101.2 | 102.0 | 102.2 | 102.0 | 100.4 | 101.4 | 101.8 | 101.3 |
|                  | 187       | AM                                  | 101.2 | 102.0 | 102.0 | 102.2 | 102.1 | 102.2 | 102.2 | 102.5 | 101.6 | 102.8 | 105.0 | 101.8 | 102.0 | 101.1 | 101.5 | 101.7 | 102.0 |
|                  |           | PM                                  |       |       | 102.2 | 102.3 | 101.8 | 101.9 | 102.4 | 101.8 | 101.6 | 102.0 | 104.6 | 102.0 | 101.8 | 101.5 | 101.0 | 100.9 | 101.0 |
|                  | 188       | AM                                  | 101.9 | 101.5 | 102.2 | 101.7 | 102.1 | 102.0 | 102.0 | 101.3 | 100.5 | 101.9 | 102.1 | 102.9 | 102.0 | 100.3 | 100.1 | 101.0 | 101.5 |
|                  |           | PM                                  |       |       | 102.4 | 102.2 | 101.6 | 102.2 | 101.8 | 101.1 | 101.1 | 101.5 | 101.6 | 101.7 | 101.8 | 100.5 | 100.6 | 99.8  | 101.9 |
|                  | 191       | AM                                  | 100.1 | 100.4 | 102.3 | 102.2 | 101.6 | 101.9 | 101.7 | 103.4 | 101.8 | 101.9 | 102.9 | 105.0 | 100.5 | 101.3 | 101.3 | 101.4 | 100.8 |
|                  |           | PM                                  |       |       | 102.2 | 101.8 | 101.3 | 102.0 | 101.4 | 103.4 | 101.4 | 101.4 | 102.2 | 104.4 | 103.2 | 99.8  | 100.9 | 100.8 | 100.6 |
|                  | 193       | AM                                  | 101.7 | 101.8 | 102.2 | 102.5 | 101.5 | 100.4 | 102.0 | 103.7 | 102.6 | 103.1 | 101.9 | 101.9 | 103.6 | 99.7  | 100.7 | 101.5 | 101.4 |
|                  |           | PM                                  |       |       | 101.8 | 102.4 | 101.9 | 101.5 | 102.2 | 103.1 | 103.1 | 103.1 | 101.7 | 102.4 | 102.3 | 100.8 | 101.8 | 100.0 | 102.0 |
|                  | 195       | AM                                  | 100.9 | 101.1 | 102.4 | 102.1 | 102.0 | 102.5 | 102.6 | 103.0 | 102.9 | 102.9 | 104.2 | 103.0 | 103.8 | 103.5 | 101.7 | 101.7 | 103.0 |
|                  |           | PM                                  |       |       | 102.6 | 102.7 | 101.3 | 101.2 | 102.4 | 103.0 | 102.2 | 102.4 | 104.7 | 102.9 | 103.2 | 104.4 | 104.6 | 103.1 | 102.1 |
|                  | 199       | AM                                  | 100.5 | 100.4 | 102.5 | 102.2 | 102.1 | 101.9 | 102.5 | 102.9 | 102.0 | 102.5 | 104.6 | 101.9 | 102.6 | 101.8 | 101.5 | 101.7 | 101.7 |
|                  |           | PM                                  |       |       | 102.0 | 102.4 | 100.8 | 102.0 | 101.9 | 102.2 | 102.8 | 102.0 | 105.5 | 101.6 | 103.4 | 101.5 | 101.4 | 101.0 | 101.0 |
|                  | 200       | AM                                  | 100.0 | 99.6  | 103.1 | 102.5 | 101.7 | 102.1 | 101.8 | 101.8 | 102.1 | 102.2 | 102.5 | 103.4 | 101.8 | 101.3 | 102.3 | 101.8 | 102.0 |
|                  |           | PM                                  |       |       | 102.4 | 102.6 | 102.4 | 102.0 | 102.2 | 101.6 | 102.2 | 102.2 | 102.1 | 103.4 | 101.6 | 104.3 | 102.0 | 101.5 | 101.4 |
|                  | 203       | AM                                  | 98.0  | 99.6  | 102.1 | 102.2 | 101.7 | 101.0 | 102.2 | 102.2 | 102.6 | 101.8 | 101.7 | 101.4 | 100.1 | 100.0 | 100.4 | 100.7 | 100.4 |
|                  |           | PM                                  |       |       | 101.8 | 102.3 | 102.1 | 101.8 | 101.7 | 102.0 | 101.0 | 101.1 | 102.8 | 102.4 | 103.2 | 99.2  | 100.0 | 101.2 | 101.8 |
|                  | 205       | AM                                  | 100.2 | 101.0 | 101.8 | 102.5 | 102.0 | 102.4 | 101.8 | 102.1 | 101.5 | 102.1 | 102.5 | 102.9 | 102.2 | 101.2 | 101.8 | 101.2 | 101.1 |
|                  |           | PM                                  |       |       | 102.0 | 101.9 | 101.1 | 101.8 | 101.6 | 101.8 | 101.1 | 101.2 | 102.0 | 102.4 | 102.2 | 101.6 | 101.1 | 101.6 | 101.6 |
|                  | 210       | AM                                  | 100.4 | 100.4 | 101.5 | 102.0 | 101.4 | 101.7 | 102.0 | 101.9 | 101.3 | 101.6 | 101.2 | 103.2 | 101.9 | 99.0  | 100.1 | 100.8 | 101.2 |
|                  |           | PM                                  |       |       | 101.6 | 101.8 | 101.7 | 101.6 | 101.8 | 101.5 | 101.8 | 101.4 | 101.3 | 101.9 | 102.6 | 100.6 | 100.3 | 101.2 | 102.1 |
|                  | 212       | AM                                  | 99.8  | 101.2 | 101.6 | 102.9 | 102.4 | 102.3 | 101.7 | 103.5 | 100.9 | 102.8 | 103.5 | 103.5 | 102.8 | 101.1 | 102.3 | 101.3 | 101.3 |
| PM               |           |                                     |       | 101.0 | 102.6 | 101.9 | 101.9 | 101.3 | 101.6 | 101.2 | 101.9 | 103.8 | 103.6 | 102.8 | 102.3 | 102.1 | 101.7 | 101.6 |       |
| 217              | AM        | 100.3                               | 99.8  | 100.3 | 101.5 | 100.5 | 102.0 | 100.7 | 101.1 | 100.4 | 101.3 | 100.6 | 100.3 | 100.3 | 99    |       |       |       |       |

Clinical Evaluations:

| Treatment Groups | Animal ID | Study Days (Day 0 is challenge day) |    |   |   |   |   |   |   |   |   |    |   |    |    |    |    |    |
|------------------|-----------|-------------------------------------|----|---|---|---|---|---|---|---|---|----|---|----|----|----|----|----|
|                  |           | -2                                  | -1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8  | 9 | 10 | 11 | 12 | 13 | 14 |
| Controls         | 166       | N                                   | N  | N | N | N | N | N | N | R | R | R  | N | N  | R  | N  | N  | N  |
|                  | 176       | N                                   | N  | N | N | N | N | N | N | R | R | C  | R | RC | C  | RC | RC | RC |
|                  | 180       | N                                   | N  | N | N | N | N | N | N | N | C | C  | N | N  | N  | N  | R  | N  |
|                  | 186       | N                                   | N  | N | N | N | N | N | N | N | R | C  | N | R  | N  | N  | C  | N  |
|                  | 192       | N                                   | N  | N | N | N | N | N | N | R | C | RC | N | N  | C  | C  | N  | N  |
|                  | 198       | N                                   | N  | N | N | N | N | N | N | R | R | R  | R | N  | N  | R  | N  | N  |
|                  | 206       | N                                   | N  | N | N | N | N | N | N | N | N | R  | R | R  | RC | R  | RC | R  |
|                  | 207       | N                                   | N  | N | N | N | N | N | N | R | C | C  | R | C  | C  | RC | RC | C  |
| Vaccinates       | 165       | N                                   | N  | N | N | N | N | N | N | N | N | N  | N | N  | N  | C  | N  | N  |
|                  | 167       | N                                   | N  | N | N | N | N | N | N | N | N | RC | N | N  | N  | N  | N  | N  |
|                  | 169       | N                                   | N  | N | N | N | N | N | N | N | N | N  | N | C  | N  | N  | C  | N  |
|                  | 170       | N                                   | N  | N | N | N | N | N | N | N | N | R  | N | R  | N  | N  | N  | N  |
|                  | 171       | N                                   | N  | N | N | N | N | N | N | N | R | N  | N | N  | N  | N  | N  | N  |
|                  | 172       | N                                   | N  | N | N | N | N | N | N | N | N | R  | N | N  | N  | N  | N  | N  |
|                  | 173       | N                                   | N  | N | N | N | N | N | N | N | N | N  | N | N  | N  | N  | N  | N  |
|                  | 177       | N                                   | N  | N | N | N | N | N | N | R | N | R  | N | N  | R  | R  | N  | N  |
|                  | 179       | N                                   | N  | N | N | N | N | N | N | N | N | N  | N | N  | N  | N  | N  | N  |
|                  | 181       | N                                   | N  | N | N | N | N | N | N | R | R | N  | N | N  | N  | N  | N  | N  |
|                  | 183       | N                                   | N  | N | N | N | N | N | N | N | N | R  | N | N  | N  | C  | C  | N  |
|                  | 185       | N                                   | N  | N | N | N | N | N | N | R | R | R  | N | N  | N  | N  | N  | N  |
|                  | 187       | N                                   | N  | N | N | N | N | N | N | N | N | R  | N | N  | N  | N  | N  | N  |
|                  | 188       | N                                   | N  | N | N | N | N | N | N | N | R | N  | N | N  | N  | N  | N  | N  |
|                  | 191       | N                                   | N  | N | N | N | N | N | N | R | R | R  | N | N  | R  | R  | R  | N  |
|                  | 193       | N                                   | N  | N | N | N | N | N | N | R | N | N  | N | N  | N  | N  | N  | N  |
|                  | 195       | N                                   | N  | N | N | N | N | N | N | R | R | R  | N | R  | N  | N  | N  | N  |
|                  | 199       | N                                   | N  | N | N | N | N | N | N | R | N | RC | N | N  | N  | C  | N  | N  |
|                  | 200       | N                                   | N  | N | N | N | N | N | N | R | R | RC | N | C  | C  | C  | C  | N  |
|                  | 203       | N                                   | N  | N | N | N | N | N | N | N | N | R  | N | N  | N  | N  | N  | N  |
|                  | 205       | N                                   | N  | N | N | N | N | N | N | R | N | R  | N | N  | N  | C  | N  | N  |
|                  | 210       | N                                   | N  | N | N | N | N | N | N | N | N | C  | N | N  | N  | N  | N  | N  |
|                  | 212       | N                                   | N  | N | N | N | N | N | N | N | N | N  | N | N  | R  | N  | N  | N  |
|                  | 217       | N                                   | N  | N | N | N | N | N | N | N | N | N  | N | N  | N  | N  | N  | N  |

Code for clinical observations:

N = Normal

R = Rhinorrhea

C =Coughing

|                                            |                                                                                                                                                                                              |
|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Study Type</b>                          | Safety                                                                                                                                                                                       |
| <b>Pertaining to</b>                       | All fractions                                                                                                                                                                                |
| <b>Study Purpose</b>                       | Demonstrate safety under field conditions                                                                                                                                                    |
| <b>Product Administration</b>              | Two doses intramuscularly with the second dose 2 to 4 weeks after the first dose                                                                                                             |
| <b>Study Animals</b>                       | A total of 8,235 heads of cows, heifers, and calves in 54 groups were included in the study: 3,968 vaccinated and 4,267 controls                                                             |
| <b>Challenge Description</b>               | N/A                                                                                                                                                                                          |
| <b>Interval observed after vaccination</b> | Animals were observed on days 1-3, 7-14 after the first dose, at the time of second dose and 1-14 post second dose. Pregnant cows were to be observed throughout the remainder of gestation. |
| <b>Results</b>                             | <p>Transient swellings at the injection site following vaccination were reported in 3 of the 54 groups that received the vaccine.</p> <p>No other adverse events were reported.</p>          |
| <b>USDA Approval Date</b>                  | 12/28/1988                                                                                                                                                                                   |