70-143

Nuclear Fuel Services, Inc. ERWIN, TENNESSEE 37650

(615) 743-914

January 30, 1981

Certified Mail
Return Receipt Requested

U. S. Nuclear Regulatory Commission
Region II
101 Marietta Street, NW
Atlanta, GA 30303

Attention: Mr. James P. O'Reilly, Director

Reference: (1) SNM 124; Docket 70-143
(2) Letter, J. P. O'Reilly to W. C. Manser, Jr.
RII: JPO 70-143 received November 24, 1980

Gentlemen:

In response to Reference 2, Item 3, please find enclosed an evaluation of the stacks at Nuclear Fuel Services, Inc.

Please call if additional information is required.

Yours very truly,

W. C. Manser, Jr.
General Manager

WCM/pts

Enclosures

cc: Mr. R. G. Page, Acting Chief
Uranium Fuel Licensing Branch
Washington, DC

18358

Introduction

The following is an evaluation of the stacks located at Nuclear Fuel Services, Inc. (NFS) in Erwin, Tennessee. This evaluation includes: description of the stacks, effluents as a yearly average for each, inspection procedures and a comparison of NFS stacks to standards.

Discussion

Each time a sample is collected, an inspection checklist is filled out. Figure I is a copy of the checklist that is now being used.

Tables IA through IP are a comparison of NFS Stacks, by stack number, to published standards. As stated in these tables, the ANSI Standard requires the use of a knife edge orifice on the sampling probes. Nuclear Fuel Services will upgrade to this standard by May 15, 1981..

Table II is a summary of the NFS stack data for 1980.

Table III is a summary of the minor improvements to be made by NFS regarding stacks and the estimated date for correction.

During this evaluation, a review of all stack data was performed. During the period from June to November, there were seven weeks during which stacks 287 and 278 exceeded reporting levels. Initial determinations indicated that this was due to cross contamination within the laboratory. To verify this, samples were sent out for isotopic uranium analysis. A review of isotopic data received in December indicated that two out of seven weeks were positively due to cross contamination. Procedures for handling and analysis of samples were changed to decrease the porbability of cross contamination of low-enriched samples by high-enriched samples. Since November, stacks 287 and 278 have not exceeded the reporting level.

Conclusion

This evaluation has shown that some minor improvements are necessary to bring all stacks into the most stringent interpretation to known standards. This upgrading has been implemented with completion scheduled for May 15, 1981.

It is concluded that the effluent sampling is representative of the effluent releases and that the measurements and data obtained therefrom accuragely reflect such releases. This conclusion is based on the following findings:

(1) Redundant samplers have been installed and operated in the two most significant effluent release points (Stacks from Buildings 233 and 302/303). Although precise day-to-day agreement of these systems are not observed, weekly and longer term averages are comparable.

(2) Since the redundant and primary samplers are designed, installed and operated in compliance with known industry and governmental standards, and the redundant samples are comparable, it is assumed that all stack sampling systems operated in accordance with such standard results in representative sampling.

(3) All stack sampling systems at NFS are operated in accordance with known standards except for the minor points on strict interpretation contained herein which will be corrected by May 15, 1981.

STACK SAMPLING INSPECTION CHECK LIST

FIGURE I: (Indicate Items Checked & Enter Date)

DATE:_____TIME:_____STACK SAMPLE #_____

REDUNDANT SAMPLE # _____(if applicable)

1. Vacuum broke at #1 impinger prior to turning off vacuum pump.
2. Probes Inspected:___Yes___No
   (complete only when probe inspection is made)

   Primary Sampler

   ___orifices clear ___plugged(no.___)

   ___condition good ___corroded ___cleaned

   ___probe lines clear ___probes aligned OK?

   Redundant Sampler

   ___orifices clear ___plugged(no.___)

   ___cond. good ___corroded ___cleaned

   ___probe line ___probes aligned OK?
3. Transfer lines to filter holder:

   Primary Sampler

   ___heat traced ___heat trace OK?

   Secondary Sampler

   ___heat traced? ___heat trace OK?

   Remarks:_____
4. Filter Holder(s)

   Primary Sampler

   ___machined surfaces OK? (smooth)

   ___screens in place and good condition

   ___"O" rings and seals in place and good condition

   ___filter removed: ___wet ___dry ___intact ___torn

   ___new filter installed and intact?

   ___assembly seal OK?

   Redundant Sampler (if applicable)

   ___machine surfaces OK?

   ___screens in good condition?

   ___"O" rings and seals in place and good condition.

   ___filter removed: __wet __dry __intact __torn

   ___new filter installed and intact?

   ___assembly seal OK?

   Remarks:_____
5. Impinger flasks, tubes, impact plates intact:

   Primary Sampler

   ___impingers

   ___all lines secure and leak tight?

   ___tube clamps in place?

   ___vacuum grease applied uniformly to ground glass joints?

   ___flask trap in place and sealed?___carry-over solution? ___collected?

   Redundant Sampler

   ___impingers

   ___all lines secure and leak tight?

   ___tube clamps in place?

   ___vacuum grease applied uniformly to ground glass joints?

   ___ flask trap in place and sealed?

   ___carry-over solution?___collected

NOTE: Pre-filter holder flask traps to be emptied, rinsed and replaced at each collection. Solution to be kept separate.

6. Vacuum pump and flow meter

   Primary Sampler

   ___flow meter clean, dry and functioning properly

   ___vacuum pump operational and good condition?

   ___flow rate prior to collection ___l pm after collection ___l pm

   Remarks:_____
7. Sampler housing and general items (Primary and Redundant Samplers)

   ___housing condition good? ___heat source (light bulbs) operating
8. Describe any other observed problem which needs correction:_____

   _____

Signed:_____

Table I-A
STACK NUMBER: 27

Table of Comparison
NFS Sampling System to Standards

Item, Function or Consideration	Standard or Other Authority Specification or Comment(1)	NFS Sampling Status
1. Stack air flow characteristics	Air flow is considered turbulant if Reynolds number is >2100	Reynolds no. is >2100; therefore flow is turbulant.
2. Stack physical dimension	-	Height: 14.9'; Dia. 16" X 17 1/2"
3. Sampling position	Minimum of 5 diameters (preferably 10) from transition, elbow to assure complete mixing	No acceptable sampling point at greater than 5 duct diameters.
4. Withdrawal points	Duct diameter 30-48": 5	4 withdrawal points
5. Sampling probe configuration	Cannot be readily standardized; should consider deposition losses, ease of removal for cleaning, avoidance of abrupt changes in flow direction to minimize inertial impaction of particles. Probe verticle intake lengths: 5D or greater. (1.43") Probe turning radius: 5D or greater(1.43") D = orifice diameter Manifold Diameter: $d = \frac{Q}{150}$ = (1.75 in) d= diameter of sample line(cm) Q= sampling rate (cm^3sec)	Sampling probe configuration: Sampling orifice sizes: .2845" Vertical intake length: 6" Probe turning radius: 3.75" Probe diameter: = 3/8"

Table 1-A
STACK NUMBER: 27

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
6. Isokinetic Sampling & Sampling Orifices	The velocity at which the sample is withdrawn must be equal to that which exists locally in the stream. Sampling probes (orifices) must be tapered to a knife edge.	The sampling velocity is established at the pitot tube measured velocity at the withdrawal point by varying the size of the orifice as related to the same rate. Stack velocities are checked frequently. The orifice is drilled to the calculated dia. Redesigned orifices with a knife edge are being ordered and will be installed as they arrive.
7. Sampling line to collector	Optimum Diameter (d)= $\frac{Q}{150}$ $(1.75")^{(2)}$	0.375"
8. Particle Collectors (Filters)	Consider collecting efficiency, air flow resistance, wet and dry strength, surface roughness, ease of chemical dissolution (when leaching is necessary).	Filter used at NFS: Whatman 41 Collection efficiency: 78% Flow resistance: 7mmHg Dry strength: Strong Surface roughness: Rough Wet strength: Reasonably strong Dissolution: Easy

Table I-A
STACK NUMBER: 27

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
9. Filter Support/Holder	Well designed including: (1) Porous backing screen or plate (2) Filter contact surface smooth, flat, free of burrs, etc. (3) Provide a compression sealing ring for air tight seal.(should be tested to assure no leakage) (4) Resistance to corrosion (5) Easily opened and closed	NFS filter holder includes: (1) Backing Plate (2) Smooth filter contact surface (3) Rubber "O" ring and teflon base seal. (4) Stainless steel construction (5) Screw type opening
10. Gas washing (Impingers) (inertial collectors)	Considerations: (1) Specific chemical reactions or preferential solubility in liquids may be used. (2) Pass air in fine bubbles through reacting liquid. Air is impinged at high velocity against a gas plate immersed in absorption media. No operating flow is recommended. (3)	NFS System employs: (1) 2 Smith-Greenberg impingers (500 ml) in series, containing a 10% solution of ammonius hydroxide (2) Efficiency of 90% emperically established.
11. Air Mover (Vacuum Pump) Flow Rate Control	Considerations: (1) Deliver necessary air flow against resistance of sampling system. (2) Maintain constant flow as resistance builds up due to filter loading.	NFS System employs: (1) Positive displacement pump with capacity of 113 lpm at zero pressure drop. Ulti e vacuum: 26 in. Hg at sea leve (2) A constant flow regulator (variable resistance valve type)

STACK NUMBER: 27

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
12. Flow Measuring Device	Flow rate must be measured. Most frequently used is "rotameter." Should be located downstream of collectors.	NFS uses a 0-50 l/m rotameter which is check calibrated to a NBS standard on those stacks which have filters only. For stacks having both filters and impingers a 0-20 l/m rotameter is used. Installed down-stream of collectors.

(1) "Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities," American National Standards Institute, Inc. ANSI N13.1, 1969, except as otherwise noted.

(2) "Nuclear Air Cleaning Handbook", U. S. Energy Research and Development Administration (DOE), ERDA 76-21, 1976

(3) "Air Sampling Instruments for Evaluation of Atmospheric Contaminents", 5th Edition, American Conference of Industrial Hygienists, 1978

Table I-3
STACK NUMBER: 28

Table of Comparison
NFS Sampling System to Standards

Item, Function or Consideration	Standard or Other Authority Specification or Comment(1)	NFS Sampling Status
1. Stack air flow characteristics	Air flow is considered turbulant if Reynolds number is >2100	Reynolds number is >2100 therefore flow is turbulant.
2. Stack physical dimension	-	Height: 14.9 ft.; Dia. 19" x 2'--
3. Sampling position	Minimum of 5 diameters (preferably 10) from transition, elbow to assure complete mixing	The distance is 7.5 ft., which is 4.1 stack diameters.
4. Withdrawal points	Duct diameter 30-48": 5	6 withdrawal points
5. Sampling probe configuration	Cannot be readily standardized; should consider deposition losses, ease of removal for cleaning, avoidance of abrupt changes in flow direction to minimize inertial impaction of particles. Probe verticle intake lengths: 5D or greater. (0.802) Probe turning radius: 5D or greater (0.802") D = orifice diameter Manifold Diameter: $d = \frac{Q}{150}$ (1.75") d= diameter of sample line(cm) Q= sampling rate (cm^3sec)	Sampling probe configuration: Sampling orifice sizes: 1604" Vertical intake length: 6 Probe turning radium: 3.75 Probe diameter: = 3/8"

Table I-B
STACK NUMBER: 28

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
6. Isokinetic Sampling & Sampling Orifices	The velocity at which the sample is withdrawn must be equal to that which exists locally in the stream. Sampling probes (orifices) must be tapered to a knife edge.	The sampling velocity is established at the pitot tube measured velocity at the withdrawal point by varying the size of the orifice as related to the same rate. Stack velocities are checked frequently. The orifice is drilled to th calculated dia. Redesigned orifices with a knife edge are being ordered and will be installed as they arrive.
7. Sampling line to collector	Optimum Diameter $(d) = \frac{Q^{(2)}}{150(1.75")}$	.375"
8. Particle Collectors (Filters)	Consider collecting efficiency, air flow resistance, wet and dry strength, surface roughness, ease of chemical dissolution (when leaching is necessary).	Filter used at NFS: Whatman 41 Collection efficiency: 78% Flow resistance: 7mm Hg Dry strength: Strong Surface Roughness: Rough Wet strength: Reasonably strong Dissolution: Easy

Table I-B
STACK NUMBER: 28

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
9. Filter Support/Holder	Well designed including: (1) Porous backing screen or plate (2) Filter contact surface smooth, flat, free of burrs, etc. (3) Provide a compression sealing ring for air tight seal.(should be tested to assure no leakage) (4) Resistance to corrosion (5) Easily opened and closed	NFS filter holder includes: (1) Backing plate (2) Smooth filter contact surface (3) Rubber "O" ring and teflon base seal. (4) Stainless steel construction (5) Screw type opening
10. Gas washing (Impingers) (inertial collectors)	Considerations: (1) Specific chemical reactions or preferential solubility in liquids may be used. (2) Pass air in fine bubbles through reacting liquid. Air is impinged at high velocity against a gas plate immersed in absorption media. No operating flow is recommended. (3)	NFS System employs: (1) 2 Smith-Greenberg impingers (500 ml) inseries, containing a 10% soltuion of ammonium hydroxide. (2) Efficiency of 90% emperically established.
11. Air Mover (Vacuum Pump) Flow Rate Control	Considerations: (1) Deliver necessary air flow against resistance of sampling system. (2) Maintain constant flow as resistance builds up due to filter loading.	NFS System employs: (1) Positive displacement pump with capacity of 113 lpm at zero pressure drop. Ultimate vacuum 26 in. Hg at sea level. (2) A constant flow regulator (variable resistance valve type)

Table I-B
STACK NUMBER: 28

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
12. Flow Measuring Device	Flow rate must be measured. Most frequently used is "rotameter." Should be located downstream of collectors.	NFS uses a 0-50 l/m rotameter which is check calibrated to an NBS standard on those stacks which have filters only. For stacks having both filters and impingers a 0-20 l/m rotameter is used. Installed down-stream of collectors.

(1) "Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities," American National Standards Institute, Inc. ANSI N13.1, 1969, except as otherwise noted.

(2) "Nuclear Air Cleaning Handbook", U. S. Energy Research and Development Administration (DOE), ERDA 76-21, 1976

(3) "Air Sampling Instruments for Evaluation of Atmospheric Contaminents", 5th Edition, American Conference of Industrial Hygienists, 1978

Table I-C
STACK NUMBER: 29

Table of Comparison
NFS Sampling System to Standards

Item, Function or Consideration	Standard or Other Authority Specification or Comment (1)	NFS Sampling Status
1. Stack air flow characteristics	Air flow is considered turbulant if Reynolds number is >2100	Reynolds number is >2100, therefore flow is turbulent.
2. Stack physical dimension	-	Height: 24.6 ft; Dia. 7" x 12"
3. Sampling position	Minimum of 5 diameters (preferably 10) from transition, elbow to assure complete mixing	The distance is 4 ft., which is 5.4 stack diameters.
4. Withdrawal points	Duct diameter 30-48": 5	2 withdrawal points
5. Sampling probe configuration	Cannot be readily standardized; should consider deposition losses, ease of removal for cleaning, avoidance of abrupt changes in flow direction to minimize inertial impaction of particles. Probe verticle intake lengths: 5D or greater. (2.11") Probe turning radius: 5D or greater (2.11") D = orifice diameter Manifold Diameter: $d = \frac{Q}{150} = (1.75")$ d= diameter of sample line(cm) Q= sampling rate (cm^3sec)	Sampling probe configuration: Sampling orifice sizes: .4221" Vertical intake length: 6 in. Probe turning radius: 3.74 Probe diameter: = 3/8"

Table I-C
STACK NUMBER: 29

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
6. Isokinetic Sampling & Sampling Orifices	The velocity at which the sample is withdrawn must be equal to that which exists locally in the stream. Sampling probes (orifices) must be tapered to a knife edge.	The sampling velocity is established a the pitot tube measured velocity at the withdrawal point to varying the si of the orifice as related to the same rate. Stack velocities are checked frequently. The orifice is drilled to calculated dia. Redesigned orifices wit a knife edge are being ordered and wil be installed as they arrive.
7. Sampling line to collector	Optimum Diameter $(d) = \frac{Q^{(2)}}{150}$ $= (1.75")$	.375"
8.. Particle Collectors (Filters)	Consider collecting efficiency, air flow resistance, wet and dry strength, surface roughness, ease of chemical dissolution (when leaching is necessary).	Filter used at NFS: Whatman 41 Collection efficiency: 78% Flow resistance: 7 mm Hg Dry strength: Strong Surface Roughness: Rough Wet Strength: Reasonably stro Dissolution: Easy

Table I-C
STACK NUMBER: 29

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
9. Filter Support/Holder	Well designed including: (1) Porous backing screen or plate (2) Filter contact surface smooth, flat, free of burrs, etc. (3) Provide a compression sealing ring for air tight seal.(should be tested to assure no leakage) (4) Resistance to corrosion (5) Easily opened and closed	NFS filter holder includes: (1) Backing plate (2) Smooth filter contact surfac (3) Rubber "O" Ring and teflon base seal (4) Stainless steel construction (5) Screw type opening
10. Gas washing (Impingers) (inertial collectors)	Considerations: (1) Specific chemical reactions or preferential solubility in liquids may be used. (2) Pass air in fine bubbles through reacting liquid. Air is impinged at high velocity against a gas plate immersed in absorption media. No operating flow is recommended. (3)	NFS system employs: (1) 2 Smith-Greenberg impingers (500 ml) in series, containi a 10% solution of ammonium hydroxide. (2) Efficiency of 90% empericall established.
11. Air Mover (Vacuum Pump) Flow Rate Control	Considerations: (1) Deliver necessary air flow against resistance of sampling system. (2) Maintain constant flow as resistance builds up due to filter loading.	NFS system employs: (1) Positive displacement pump with capacity of 113 lpm at zero pressure drop. Ult te vacuum: 26 in. Hg at sea ev (2) A constant flow regulator (variable resistance valve type)

Table I-C
STACK NUMBER: 29

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
12. Flow Measuring Device	Flow rate must be measured. Most frequently used is "rotameter." Should be located downstream of collectors.	NFS uses a 0-50 l/m rotameter which is check calibrated to an NBS standard on those stacks which have filters only. For stacks having both filters and impingers a 0-20 l/m rotameter is used. Installed down-stream of collectors.

(1) "Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities," American National Standards Institute, Inc. ANSI N13.1, 1969, except as otherwise noted.

(2) "Nuclear Air Cleaning Handbook", U. S. Energy Research and Development Administration (DOE), ERDA 76-21, 1976

(3) "Air Sampling Instruments for Evaluation of Atmospheric Contaminents", 5th Edition, American Conference of Industrial Hygienists, 1978

Table I-D
STACK NUMBER: 224

Table of Comparison
NFS Sampling System to Standards

Item, Function or Consideration	Standard or Other Authority Specification or Comment(1)	NFS Sampling Status
1. Stack air flow characteristics	Air flow is considered turbulant if Reynolds number is >2100	Reynolds number is >2100, therefore flow is turbulent.
2. Stack physical dimension	-	Height: 29.5 ft; Dia. 7" x 12"
3. Sampling position	Minimum of 5 diameters (preferably 10) from transition, elbow to assure complete mixing	The distance is 4.0 ft., which is 5.4 stack diameters
4. Withdrawal points	Duct diameter 30-48": 5	1 withdrawal point
5. Sampling probe configuration	Cannot be readily standardized; should consider deposition losses, ease of removal for cleaning, avoidance of abrupt changes in flow direction to minimize inertial impaction of particles. Probe verticle intake lengths: 5D or greater. (2.76") Probe turning radius: 5D or greater D = orifice diameter = (2.76") Manifold Diameter: $d = \frac{Q}{150}$ (1.75") d= diameter of sample line(cm) Q= sampling rate (cm^3sec)	Sampling probe configuration: Sampling orifice sizes: .5520" Vertical intake length: 6" Probe turning radius: 3.75" Probe diameter: = 3/8"

Table I-D
STACK NUMBER: 224

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
6. Isokinetic Sampling & Sampling Orifices	The velocity at which the sample is withdrawn must be equal to that which exists locally in the stream. Sampling probes (orifices) must be tapered to a knife edge.	The sampling velocity is establishe at the pitot tube measured velocity at the withdrawal point to varying the size of the orifice as related to the same rate. Stack velocities are checked frequently. The orifice is drilled to the calculated dia. Redesigned orifices with a knife edge are being ordered and will be installed as they arrive.
7. Sampling line to collector	Optimum Diameter $(d) = \frac{Q}{150}^{(2)}$ $= (1.75")$	.375"
8. Particle Collectors (Filters)	Consider collecting efficiency, air flow resistance, wet and dry strength, surface roughness, ease of chemical dissolution (when leaching is necessary).	Filter used at NFS: Whatman 41 Collection Efficiency: 78% Flow resistance: 7 mm Hg Dry strength: strong Surface roughness: rough Wet strength: Reasonably stron Dissolution: Easy

Table 1-D
STACK NUMBER: 224

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
9. Filter Support/Holder	Well designed including: (1) Porous backing screen or plate (2) Filter contact surface smooth, flat, free of burrs, etc. (3) Provide a compression sealing ring for air tight seal.(should be tested to assure no leakage) (4) Resistance to corrosion (5) Easily opened and closed	NFS filter holder includes: (1) Backing plate (2) Smooth filter contact surface (3) Rubber "O" ring and teflon base seal (4) Stainless steel construction (5) Screw type opening
10. Gas washing (Impingers) (inertial collectors)	Considerations: (1) Specific chemical reactions or preferential solubility in liquids may be used. (2) Pass air in fine bubbles through reacting liquid. Air is impinged at high velocity against a gas plate immersed in absorption media. No operating flow is recommended. (3)	NFS system employs: (1) 2 Smith-Greenberg impingers (500 ml) in series, containing (2) Efficiency of 90% emperical established
11. Air Mover (Vacuum Pump) Flow Rate Control	Considerations: (1) Deliver necessary air flow against resistance of sampling system. (2) Maintain constant flow as resistance builds up due to filter loading.	NFS system employs: (1) Positive displacement pump with capacity of 113 lpm at zero pressure drop. Ultimate vacuum: 26 in. Hg at sea level. (2) A constant flow regulator (variable resistance valve type)

Table I-D
STACK NUMBER: 224

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
12. Flow Measuring Device	Flow rate must be measured. Most frequently used is "rotameter." Should be located downstream of collectors.	NFS useds a 0-50 l/m rotameter which is check calibrated to an NBS standard on those stacks which have filters only. For stacks having both filters and impingers a 0-20 l/m rotameter is used. Install down stream of collectors.

(1) "Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities," American National Standards Institute, Inc. ANSI N13.1, 1969, except as otherwise noted.

(2) "Nuclear Air Cleaning Handbook", U. S. Energy Research and Development Administration (DOE), ERDA 76-21, 1976

(3) "Air Sampling Instruments for Evaluation of Atmospheric Contaminents", 5th Edition, American Conference of Industrial Hygienists, 1978

Table I-E
STACK NUMBER: 36

Table of Comparison
NFS Sampling System to Standards

Item, Function or Consideration	Standard or Other Authority Specification or Comment (1)	NFS Sampling Status
1. Stack air flow characteristics	Air flow is considered turbulant if Reynolds number is >2100	Reynolds number is >2100; therefore flow is turbulent.
2. Stack physical dimension	-	Height: 38.5 ft.; Dia. 12" x 15"
3. Sampling position	Minimum of 5 diameters (preferably 10) from transition, elbow to assure complete mixing	No acceptable sampling point at greater than 5 duct diameters.
4. Withdrawal points	Duct diameter 30-48": 5	4 withdrawal points
5. Sampling probe configuration	Cannot be readily standardized; should consider deposition losses, ease of removal for cleaning, avoidance of abrupt changes in flow direction to minimize inertial impaction of particles. Probe verticle intake lengths: 5D or greater. (1.33") Probe turning radius: 5D or greater (1.33") D = orifice diameter Manifold Diameter: $d = \frac{Q}{150} = (1.75")$ d= diameter of sample line(cm) Q= sampling rate (cm^3sec)	Sampling probe configuration: Sampling orifice sizes: .2650" Vertical intake length: 6" Probe turning radius: 3.75" Probe diameter: = 3/8"

Table I-E
STACK NUMBER: 36

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
6. Isokinetic Sampling & Sampling Orifices	The velocity at which the sample is withdrawn must be equal to that which exists locally in the stream. Sampling probes (orifices) must be tapered to a knife edge.	The sampling velocity is establishe at the pitot tube measured velocity at the withdrawal point by varying the size of the orifice as related to the same rate. Stack velocities are checked frequently. The orifice is drilled to the calculated dia. Redesigned orifices with a knife edg are being ordered and will be installed as they arrive.
7. Sampling line to collector	Optimum Diameter (d)= $\sqrt[(2)]{\frac{Q}{150}}$ = (1.75")	.375"
8. Particle Collectors (Filters)	Consider collecting efficiency, air flow resistance, wet and dry strength, surface roughness, ease of chemical dissolution (when leaching is necessary).	Filter used at NFS: Whatman a41 Collection efficiency: 78% Flow resistance: 7 mm Hg Dry strength: Strong Surface roughness: Rough Wet strength: Reasonably strong Dissolution: Easy

Table I-E
STACK NUMBER: 36

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
9. Filter Support/Holder	Well designed including: (1) Porous backing screen or plate (2) Filter contact surface smooth, flat, free of burrs, etc. (3) Provide a compression sealing ring for air tight seal.(should be tested to assure no leakage) (4) Resistance to corrosion (5) Easily opened and closed	NFS filter holder includes: (1) Backing plate (2) Smooth filter contact surface (3) Rubber "O"Ring and teflon base seal (4) Stainless steel construction (5) Screw type opening
10. Gas washing (Impingers) (inertial collectors)	Considerations: (1) Specific chemical reactions or preferential solubility in liquids may be used. (2) Pass air in fine bubbles through reacting liquid. Air is impinged at high velocity against a gas plate immersed in absorption media. No operating flow is recommended. (3)	NFS system employs: (1) 2 Smith-Greenberg impingers (500 ml)in series, containing a 10% solution of ammonium hydroxide. (2) Efficiency of 90% emperical established.
11. Air Mover (Vacuum Pump) Flow Rate Control	Considerations: (1) Deliver necessary air flow against resistance of sampling system. (2) Maintain constant flow as resistance builds up due to filter loading.	NFS system employs: (1) Positive displacement pump with capacity of 113 l m at zero pressure drop. Ultimate vacuum: 26 in. Hg sea level. (2) A constant flow regulator (variable resistance valve type)

Table 1-E
STACK NUMBER: 36

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
12. Flow Measuring Device	Flow rate must be measured. Most frequently used is "rotameter." Should be located downstream of collectors.	NFS uses a 0-50 l/m rotameter which is check calibrated to an NBS standard on those stacks which have filters only. For stacks having both filters and impingers a 0-20 l/m rotameter is used. Installed down stream of collectors.

(1) "Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities," American National Standards Institute, Inc. ANSI N13.1, 1969., except as otherwise noted.

(2) "Nuclear Air Cleaning Handbook", U. S. Energy Research and Development Administration (DOE), ERDA 76-21, 1976

(3) "Air Sampling Instruments for Evaluation of Atmospheric Contaminents", 5th Edition, American Conference of Industrial Hygienists, 1978

Table I-F
STACK NUMBER: 103

Table of Comparison
NFS Sampling System to Standards

Item, Function or Consideration	Standard or Other Authority Specification or Comment (1)	NFS Sampling Status
1. Stack air flow characteristics	Air flow is considered turbulant if Reynolds number is >2100	Reynolds number is > 2100, therefore flow is turbulent
2. Stack physical dimension	-	Height: 4.9 ft. ; Diameter 14" x 1
3. Sampling position	Minimum of 5 diameters (preferably 10) from transition, elbow to assure complete mixing	The distance is 5.5 ft., which is 5.7 stack diameters.
4. Withdrawal points	Duct diameter 30-48": 5	4 withdrawal points
5. Sampling probe configuration	Cannot be readily standardized; should consider deposition losses, ease of removal for cleaning, avoidance of abrupt changes in flow direction to minimize inertial impaction of particles. Probe verticle intake lengths: 5D or greater. = (1.90") Probe turning radius: 5D or greater =(1.90") D = orifice diameter Manifold Diameter: $d = \frac{Q}{150} = 1.75"$ d= diameter of sample line(cm) Q= sampling rate (cm^3sec)	Sampling probe configuration: Sampling orifice sizes: .380" Vertical intake length: 6" Probe turning radium: 3.75" Probe diameter: = 3/8"

Table I-F
STACK NUMBER: 103

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
6. Isokinetic Sampling & Sampling Orifices	The velocity at which the sample is withdrawn must be equal to that which exists locally in the stream. Sampling probes (orifices) must be tapered to a knife edge.	The sampling velocity is establishe at the pitot tube measured velocity at the withdrawal point by varying the size of the orifice as related to the sample rate. Stack velocitie are checked frequently. The orifice is drilled to the calculated dia. Redesigned orifices with a knife edge are being ordered and will be installed as they arrive.
7. Sampling line to collector	Optimum Diameter (d)= $\frac{Q^{(2)}}{150}$ = (1.75")	.375"
8. Particle Collectors (Filters)	Consider collecting efficiency, air flow resistance, wet and dry strength, surface roughness, ease of chemical dissolution (when leaching is necessary).	Filter used at NFS: Whatman 41 Collection efficiency: 78% Flow resistance: 7mm Hg Dry Strength: Strong Surface roughness: Rough Wet Strength: Reasonably strong Dissolution: Easy

Table I-F
STACK NUMBER: 103

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
9. Filter Support/Holder	Well designed including: (1) Porous backing screen or plate (2) Filter contact surface smooth, flat, free of burrs, etc. (3) Provide a compression sealing ring for air tight seal.(should be tested to assure no leakage) (4) Resistance to corrosion (5) Easily opened and closed	NFS Holder includes: (1) Backing plate (2) Smooth filter contact surface (3) Rubber "O" ring and teflon base seal. (4) Stainless steel construction (5) Screw type opening
10. Gas washing (Impingers) (inertial collectors)	Considerations: (1) Specific chemical reactions or preferential solubility in liquids may be used. (2) Pass air in fine bubbles through reacting liquid. Air is impinged at high velocity against a gas plate immersed in absorption media. No operating flow is recommended. (3)	NFS System employs: (1) 2 Smith-Greenberg impingers (500 ml) in series, containing a 10% solution of ammonium hydroxide. (2) Efficiency of 90% emperically established.
11. Air Mover (Vacuum Pump) Flow Rate Control	Considerations: (1) Deliver necessary air flow against resistance of sampling system. (2) Maintain constant flow as resistance builds up due to filter loading.	NFS System employs: (1) Positive displacement pump with capacity of 113 l pm at zero pressure drop. Ultimate vacuum: 26 in. Hg at sea level. (2) A constant flow regulator (variable resistance valve type)

Table I-F
STACK NUMBER: 103

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
12. Flow Measuring Device	Flow rate must be measured. Most frequently used is "rotameter." Should be located downstream of collectors.	NFS uses a 0-50 l/m rotameter which is check calibrated to an NBS standard on those stacks which have filters only. For stacks having both filters and impingers a 0-20 l/m rotameter is used. Installed downstream of collectors.

(1) "Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities," American National Standards Institute, Inc. ANSI N13.1, 1969, except as otherwise noted.

(2) "Nuclear Air Cleaning Handbook", U. S. Energy Research and Development Administration (DOE), ERDA 76-21, 1976

(3) "Air Sampling Instruments for Evaluation of Atmospheric Contaminents", 5th Edition, American Conference of Industrial Hygienists, 1978

Table I-G
STACK NUMBER: 104

Table of Comparison
NFS Sampling System to Standards

Item, Function or Consideration	Standard or Other Authority Specification or Comment (1)	NFS Sampling Status
1. Stack air flow characteristics	Air flow is considered turbulant if Reynolds number is >2100	Reynolds number is >2100; therefor flow is turbulent.
2. Stack physical dimension	-	Height: 4.9 ft.; Dia. 14" x 16"
3. Sampling position	Minimum of 5 diameters (preferably 10) from transition, elbow to assure complete mixing	The distance is 5.5 ft., whic.. is 5.7 stack diameters.
4. Withdrawal points	Duct diameter 30-48": 5	4 withdrawal points
5. Sampling probe configuration	Cannot be readily standardized; should consider deposition losses, ease of removal for cleaning, avoidance of abrupt changes in flow direction to minimize inertial impaction of particles. Probe verticle intake lengths: 5D or greater. (1.80") Probe turning radius: 5D or greater=(1.80") D = orifice diameter Manifold Diameter: $d = \frac{Q}{150}$ = (1.75") d= diameter of sample line(cm) Q= sampling rate (cm^3sec)	Sampling probe configuration: Sampling orifice sizes: .360" Vertical intake length: 6" Probe turning radium: 3.75" Probe diameter: = 3/8"

Table I-G
STACK NUMBER: 104

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
6. Isokinetic Sampling & Sampling Orifices	The velocity at which the sample is withdrawn must be equal to that which exists locally in the stream. Sampling probes (orifices) must be tapered to a knife edge.	The sampling velocity is establishe at the pitot tube measured velocity at the withdrawal point by varying the size of the orifice as related to the same rate. Stack velocities are checked frequently. The orifice is drilled to the calculated dia. Redesigned orifices with a knife edge are being ordered and will be installed as they arrive.
7. Sampling line to collector	Optimum Diameter (d)= $\frac{Q}{150}^{(2)}$ =(1.75")	.375"
8. Particle Collectors (Filters)	Consider collecting efficiency, air flow resistance, wet and dry strength, surface roughness, ease of chemical dissolution (when leaching is necessary).	Filter used at NFS: Whatman 41 Collection Efficiency: 78% Flow resistance: 7.0 mm Hg Dry strength: Strong Surface roughness: Rough Wet Strength: Reasonably stron Dissolution: Easy

Table I-G
STACK NUMBER: 104

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
9. Filter Support/Holder	Well designed including: (1) Porous backing screen or plate (2) Filter contact surface smooth, flat, free of burrs, etc. (3) Provide a compression sealing ring for air tight seal.(should be tested to assure no leakage) (4) Resistance to corrosion (5) Easily opened and closed	NFS filter holder includes: (1) Backing plate (2) Smooth filter contact surface (3) Rubber "O" ring and teflon base seal. (4) Stainless steel construction (5) Screw type opening
10. Gas washing (Impingers) (inertial collectors)	Considerations: (1) Specific chemical reactions or preferential solubility in liquids may be used. (2) Pass air in fine bubbles through reacting liquid. Air is impinged at high velocity against a gas plate immersed in absorption media. No operating flow is recommended. (3)	NFS system employs: (1) 2 Smith-Greenberg impingers (500 ml) in series, containing a 10% solution of ammonium hydroxide. (2) Efficiency of 90% emperically established.
11. Air Mover (Vacuum Pump) Flow Rate Control	Considerations: (1) Deliver necessary air flow against resistance of sampling system. (2) Maintain constant flow as resistance builds up due to filter loading.	NFS system employs: (1) Positive displacement pump with capacity of 113 lpm at zero pressure drop. Ultimate vacuum: 26 in. Hg at sea level. (2) A constant flow regulator (variable resistance valve typ

Table I-G
STACK NUMBER: 104

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
12. Flow Measuring Device	Flow rate must be measured. Most frequently used is "rotameter." Should be located downstream of collectors.	NFS uses a 0-50 l/m rotameter whi is check calibrated to an NBS standard on those stacks which ha filters only. For stacks having both filters and impingers a 0-20 l/m rotameter is used. Installed downstream of collectors.

(1) "Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities," American National Standards Institute, Inc. ANSI N13.1, 1969, except as otherwise noted.

(2) "Nuclear Air Cleaning Handbook", U. S. Energy Research and Development Administration (DOE), ERDA 76-21, 1976

(3) "Air Sampling Instruments for Evaluation of Atmospheric Contaminents", 5th Edition, American Conference of Industrial Hygienists, 1978

Table I-H
STACK NUMBER: 185

Table of Comparison
NFS Sampling System to Standards (1)

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
1. Stack air flow characteristics	Air flow is considered turbulant if Reynolds number is >2100	Reynolds numberis >2100; therefore flow is turbulent.
2. Stack physical dimension	-	Height: 14.9 ft.,; Dia. 8"
3. Sampling position	Minimum of 5 diameters (preferably 10) from transition, elbow to assure complete mixing	There is no acceptable sampling point at greater than 5 duct dias.
4. Withdrawal points	Duct diameter 30-48": 5	1 withdrawal point
5. Sampling probe configuration	Cannot be readily standardized; should consider deposition losses, ease of removal for cleaning, avoidance of abrupt changes in flow direction to minimize inertial impaction of particles. Probe verticle intake lengths: 5D or greater. (2.48) Probe turning radius: 5D or greater(2.48") D = orifice diameter Manifold Diameter: $d = \frac{Q}{150} = (1.75")$ d= diameter of sample line(cm) Q= sampling rate (cm^3sec)	Sampling probe configuration: Sampling orifice sizes: .4967" Vertical intake length: 6" Probe turning radius: 3.75" Probe diameter: = 3/8"

Table I-H
STACK NUMBER: 185

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
6. Isokinetic Sampling & Sampling Orifices	The velocity at which the sample is withdrawn must be equal to that which exists locally in the stream. Sampling probes (orifices) must be tapered to a knife edge.	The sampling velocity is establishe at the pitot tube measured velocity at the withdrawal point by varying the size of the orifice as related to the same rate. Stack velocities are checked frequently. The orifice is drilled to the calculated dia. Redesigned orifices with a knife edge are being ordered and will be installed as they arrive.
7. Sampling line to collector	Optimum Diameter (d)= $\frac{Q^{(2)}}{150}$ =(1.75")	.375"
8. Particle Collectors (Filters)	Consider collecting efficiency, air flow resistance, wet and dry strength, surface roughness, ease of chemical dissolution (when leaching is necessary).	Filter used at NFS: Whatman 41 Collection Efficiency: 78% Flow resistance: 7mm Hg Dry strength: strong Surface roughness: Rough Wet strength: Reasonably stror Dissolution: Easy

Table I-H
STACK NUMBER: 185

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
9. Filter Support/Holder	Well designed including: (1) Porous backing screen or plate (2) Filter contact surface smooth, flat, free of burrs, etc. (3) Provide a compression sealing ring for air tight seal.(should be tested to assure no leakage) (4) Resistance to corrosion (5) Easily opened and closed	NFS filter holder includes: (1) Backing plate (2) Smooth filter contact surface (3) Rubber "O" ring and teflon bas seal. (4) Stainless steel construction (5) Screw type opening
10. Gas washing (Impingers) (inertial collectors)	Considerations: (1) Specific chemical reactions or preferential solubility in liquids may be used. (2) Pass air in fine bubbles through reacting liquid. Air is impinged at high velocity against a gas plate immersed in absorption media. No operating flow is recommended. (3)	NFS system employs: (1) 2 Smith-Greenberg impingers (500 ml) in series, containing a 10% solution of ammonium hydroxide. (2) Efficiency of 90% emperically established.
11. Air Mover (Vacuum Pump) Flow Rate Control	Considerations: (1) Deliver necessary air flow against resistance of sampling system. (2) Maintain constant flow as resistance builds up due to filter loading.	NFS system employs: (1) Positive displacement pump with capacity of 113 lpm at zero pressure drop. Ultim[illegible] vacuum" 26 in. Hg at sea [illegible]vel (2) A constant flow regulator (variable resistance valve typ

Table I-H
STACK NUMBER: 185

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
12. Flow Measuring Device	Flow rate must be measured. Most frequently used is "rotameter." Should be located downstream of collectors.	NFS uses a 0-50 l/m rotameter whic is check calibrated to an NBS stan dard on those stacks whihc have filters only. For stacks having bo filters and impingers a 0-20 l/m rotameter is used. Installed down-stream of collectors.

(1) "Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities," American National Standards Institute, Inc. ANSI N13.1, 1969, except as otherwise noted.

(2) "Nuclear Air Cleaning Handbook", U. S. Energy Research and Development Administration (DOE), ERDA 76-21, 1976

(3) "Air Sampling Instruments for Evaluation of Atmospheric Contaminents", 5th Edition, American Conference of Industrial Hygienists, 1978

STACK NUMBER: 253

Table of Comparison
NFS Sampling System to Standards

Item, Function or Consideration	Standard or Other Authority Specification or Comment (1)	NFS Sampling Status
1. Stack air flow characteristics	Air flow is considered turbulant if Reynolds number is >2100	Reynolds number is >2100 therefore flow is turbulent
2. Stack physical dimension	-	Height: 19.8 ft; Dia. 8"
3. Sampling position	Minimum of 5 diameters (preferably 10) from transition, elbow to assure complete mixing	The distance is 42.0 inches, which is 5.2 stack diameters.
4. Withdrawal points	Duct diameter 30-48": 5	1 withdrawal point
5. Sampling probe configuration	Cannot be readily standardized; should consider deposition losses, ease of removal for cleaning, avoidance of abrupt changes in flow direction to minimize inertial impaction of particles. Probe verticle intake lengths: 5D or greater. = (1.98") Probe turning radius: 5D or greater (1.98") D = orifice diameter Manifold Diameter: $d = \frac{Q}{150}$ = (1.75") d= diameter of sample line(cm) Q= sampling rate (cm^3sec)	Sampling probe configuration: Sampling orifice sizes: .3962 Vertical intake length: 6" Probe turning radius: 3.75 Probe diameter: = 3/8"

Table I-I
STACK NUMBER: 253

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
6. Isokinetic Sampling & Sampling Orifices	The velocity at which the sample is withdrawn must be equal to that which exists locally in the stream. Sampling probes (orifices) must be tapered to a knife edge.	The sampling velocity is established at the pitot tube measured velocity at the withdrawal point by varying the size of the orifice as related to the same rate. Stack velocities are checked frequently. The orifice is drilled to the calculated dia. Redesigned orifices with a knife edge are being ordered and will be installed as they arrive.
7. Sampling line to collector	Optimum Diameter (d)= $\frac{Q}{150} = \overset{(2)}{(1.75")}$	.375"
8. Particle Collectors (Filters)	Consider collecting efficiency, air flow resistance, wet and dry strength, surface roughness, ease of chemical dissolution (when leaching is necessary).	Filter used at NFS: Whatman 41 Collection efficiency: 78% Flow resistance: 7mm Hg Dry strength: Strong Surface roughness: Rough Wet Strength: Reasonably stron Dissolution: Easy

Table I-I
STACK NUMBER: 253

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
9. Filter Support/Holder	Well designed including: (1) Porous backing screen or plate (2) Filter contact surface smooth, flat, free of burrs, etc. (3) Provide a compression sealing ring for air tight seal.(should be tested to assure no leakage) (4) Resistance to corrosion (5) Easily opened and closed	NFS filter holder includes: (1) Backing plate (2) Smooth filter contact surface (3) Rubber "O" ring and teflon vase seal (4) Stainless steel construction (5) Screw type opening
10. Gas washing (Impingers) (inertial collectors)	Considerations: (1) Specific chemical reactions or preferential solubility in liquids may be used. (2) Pass air in fine bubbles through reacting liquid. Air is impinged at high velocity against a gas plate immersed in absorption media. No operating flow is recommended. (3)	NFS system employs: (1) 2 Smith-Greenberg impingers (500 ml) in series, containing a 10% solution of ammonium hydroxide. (2) Efficiency of 90% emperically established
11. Air Mover (Vacuum Pump) Flow Rate Control	Considerations: (1) Deliver necessary air flow against resistance of sampling system. (2) Maintain constant flow as resistance builds up due to filter loading.	NFS system employs: (1) Positive displacement pump with capacity of 113 l pm at zero pressure drop. Ultimate vacuum: 26" Hg at sea level. (2) A constant flow regulator (variable resistance valve typ

Table I-I
STACK NUMBER: 253

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
12. Flow Measuring Device	Flow rate must be measured. Most frequently used is "rotameter." Should be located downstream of collectors.	NFS uses a 0-50 l/m rotameter which is check calibrated to an NBS standard on those stacks which have filters only. For stacks having both filters and impingers a 0-20 l/m rotameter is used. Installed downstream of collectors.

(1) "Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities," American National Standards Institute, Inc. ANSI N13.1, 1969, except as otherwise noted.

(2) "Nuclear Air Cleaning Handbook", U. S. Energy Research and Development Administration (DOE), ERDA 76-21, 1976

(3) "Air Sampling Instruments for Evaluation of Atmospheric Contaminents", 5th Edition, American Conference of Industrial Hygienists, 1978

STACK NUMBER: 317

Table of Comparison
NFS Sampling System to Standards

Item, Function or Consideration	Standard or Other Authority Specification or Comment (1)	NFS Sampling Status
1. Stack air flow characteristics	Air flow is considered turbulant if Reynolds number is >2100	Reynolds number is >2100; therefor flow is turbulent.
2. Stack physical dimension	-	Height: 32 ft.; diameter 14"
3. Sampling position	Minimum of 5 diameters (preferably 10) from transition, elbow to assure complete mixing	The distance is 7.0 ft., whic. is 5.8 stack diameters.
4. Withdrawal points	Duct diameter 30-48": 5	3 withdrawal points
5. Sampling probe configuration	Cannot be readily standardized; should consider deposition losses, ease of removal for cleaning, avoidance of abrupt changes in flow direction to minimize inertial impaction of particles. Probe verticle intake lengths: 5D or greater. (1.04") Probe turning radius: 5D or greater=(1.04") D = orifice diameter Manifold Diameter: $d = \frac{Q}{150}$ = (.44") d= diameter of sample line(cm) Q= sampling rate (cm^3sec)	Sampling probe configuration: Sampling orifice sizes: .207-.209" Vertical intake length: 6" Probe turning radius: 3.75" Probe dia. = 0.50"

Table I-J
STACK NUMBER: 317

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
6. Isokinetic Sampling & Sampling Orifices	The velocity at which the sample is withdrawn must be equal to that which exists locally in the stream. Sampling probes (orifices) must be tapered to a knife edge.	The sampling velocity is establishe at the pitot tube measured velocity at the withdrawal point to varying the size of the orifice as related to the sample rate. Stack velocitie are checked frequently. The orifice is drilled to the calculated dia. Redesigned orifices with a knife edge are being ordered and will be installed as they arrive.
7. Sampling line to collector	Optimum Diameter (d)= $\frac{Q}{150}^{(2)}$ =(0.44)	0.50"
8. Particle Collectors (Filters)	Consider collecting efficiency, air flow resistance, wet and dry strength, surface roughness, ease of chemical dissolution (when leaching is necessary).	Filter used at NFS: Whatman 41 Collection efficiency: 78% Flow resistance: 7mm Hg Dry strength: Strong Dissolution: Easy

Table I-J
STACK NUMBER: 317

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
9. Filter Support/Holder	Well designed including: (1) Porous backing screen or plate (2) Filter contact surface smooth, flat, free of burrs, etc. (3) Provide a compression sealing ring for air tight seal.(should be tested to assure no leakage) (4) Resistance to corrosion (5) Easily opened and closed	NFS filter holder includes: (1) Backing plate (2) Smooth filter contact surface (3) Rubber "O" ring and teflon base seal (4) Stainless steel construction (5) Screw type opening
10. Gas washing (Impingers) (inertial collectors)	Considerations: (1) Specific chemical reactions or preferential solubility in liquids may be used. (2) Pass air in fine bubbles through reacting liquid. Air is impinged at high velocity against a gas plate immersed in absorption media. No operating flow is recommended. (3)	NFS System employs: (1) 2 Smith-Greenberg impingers (500 ml) in series, containing a 10% solution of ammonium hydroxide. (2) Efficiency of 90% emperically established.
11. Air Mover (Vacuum Pump) Flow Rate Control	Considerations: (1) Deliver necessary air flow against resistance of sampling system. (2) Maintain constant flow as resistance builds up due to filter loading.	NFS System employs: (1) Positive displacement pump with capacity of 113 lpm at zero pressure drop. Ultimate vacuum: 26 in. Hg at sea level (2) A constant flow regulator (variable resistance valve type

Table I-J
STACK NUMBER: 317

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
12. Flow Measuring Device	Flow rate must be measured. Most frequently used is "rotameter." Should be located downstream of collectors	NFS uses a 0-50 l/m rotameter which is check calibrated to an NBS standard on those stacks which have filters only. For stacks having both filters and impingers a 0-20 l/m rotameter is used. Installed downstream of collectors.

(1) "Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities," American National Standards Institute, Inc. ANIS N13.1, 1969, except as otherwise noted.

(2) "Nuclear Air Cleaning Handbook", U. S. Energy Research and Development Administration (DOE), ERDA 76-21, 1976

(3) "Air Sampling Instruments for Evaluation of Atmospheric Contaminents", 5th Edition, American Conference of Industrial Hygienists, 1978

Table I-K
STACK NUMBER: 278

Table of Comparison
NFS Sampling System to Standards

Item, Function or Consideration	Standard or Other Authority Specification or Comment (1)	NFS Sampling Status
1. Stack air flow characteristics	Air flow is considered turbulant if Reynolds number is >2100	Reynolds number is >2100;therefore flow is turbulent.
2. Stack physical dimension	-	Height: 22.7 ft.; Dia. 6"
3. Sampling position	Minimum of 5 diameters (preferably 10) from transition, elbow to assure complete mixing	The distance is 5 ft., which is 10.0 stack diameters.
4. Withdrawal points	Duct diameter 30-48": 5	1 withdrawal point
5. Sampling probe configuration	Cannot be readily standardized; should consider deposition losses, ease of removal for cleaning, avoidance of abrupt changes in flow direction to minimize inertial impaction of particles. Probe verticle intake lengths: 5D or greater. = (1.332") Probe turning radius: 5D or greater = (1.332) D = orifice diameter Manifold Diameter: $d = \frac{Q}{150}$ = (1.75") d= diameter of sample line(cm) Q= sampling rate (cm^3sec)	Sampling probe configuration: Sampling orifice sizes: .2664 Vertical intake length: 6" Probe turning radius: 3.75 Probe diameter: = 3/8"

Table I-K
STACK NUMBER: 278

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
6. Isokinetic Sampling & Sampling Orifices	The velocity at which the sample is withdrawn must be equal to that which exists locally in the stream. Sampling probes (orifices) must be tapered to a knife edge.	The sampling velocity is establishe at the pitot tube measured velocity at the withdrawal point by varying the size of the orifice as related to the sample rate. Stack velocitie are checked frequently. The orifice is drilled to the calculated dia. Redesigned orifices with a knife are being ordered and will be installed as they arrive.
7. Sampling line to collector	Optimum Diameter (d)= $\frac{Q}{150}$ = $\frac{(2)}{(1.75")}$	.375"
8. Particle Collectors (Filters)	Consider collecting efficiency, air flow resistance, wet and dry strength, surface roughness, ease of chemical dissolution (when leaching is necessary).	Filter used at NFS: Whatman 41 Collection efficiency: 78% Flow resistance: 7mm Hg Dry strength: Strong Surface Roughness: Rough Wet strength: Reasonably stron Dissolution: Easy

Table I-K
STACK NUMBER: 278

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
9. Filter Support/Holder	Well designed including: (1) Porous backing screen or plate (2) Filter contact surface smooth, flat, free of burrs, etc. (3) Provide a compression sealing ring for air tight seal.(should be tested to assure no leakage) (4) Resistance to corrosion (5) Easily opened and closed	NFS filter holder includes: (1) Backing plate (2) Smooth filter contact surface (3) Rubber "O" ring and teflon bas seal (4) Stainless steel construction (5) Screw type opening
10. Gas washing (Impingers) (inertial collectors)	Considerations: (1) Specific chemical reactions or preferential solubility in liquids may be used. (2) Pass air in fine bubbles through reacting liquid. Air is impinged at high velocity against a gas plate immersed in absorption media. No operating flow is recommended. (3)	NFS System employs: (1) 2 Smith-Greenberg impingers (500 ml) in series, containing a 10% solution of ammonium hydroxide. (2) Efficiency of 90% emperically established
11. Air Mover (Vacuum Pump) Flow Rate Control	Considerations: (1) Deliver necessary air flow against resistance of sampling system. (2) Maintain constant flow as resistance builds up due to filter loading.	NFS Systerm employs: (1) Positive displacement pump with capacity of 113 lpm at zero pressure drop. Ultir e vacuum: 26 in. Hg at sea vel (2) A constant flow regulator (variable resistance valve typ

Table I-K
STACK NUMBER: 278

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
12. Flow Measuring Device	Flow rate must be measured. Most frequently used is "rotameter." Should be located downstream of collectors.	NFS uses a 0-50 l/m rotameter whic is check calibrated to an NBS standard on those stacks which hav filters only. For stacks having both filters and impingers a 0-20 l/m rotameter is used. Installed downstream of collectors.

(1) "Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities," American National Standards Institute, Inc. ANSI N13.1, 1969, except as otherwise noted.

(2) "Nuclear Air Cleaning Handbook", U. S. Energy Research and Development Administration (DOE), ERDA 76-21, 1976

(3) "Air Sampling Instruments for Evaluation of Atmospheric Contaminents", 5th Edition, American Conference of Industrial Hygienists, 1978

Table I-L
STACK NUMBER: 287

Table of Comparison
NFS Sampling System to Standards

Item, Function or Consideration	Standard or Other Authority Specification or Comment (1)	NFS Sampling Status
1. Stack air flow characteristics	Air flow is considered turbulant if Reynolds number is >2100	Reynolds number is >2100; therefore, flow is turbulent.
2. Stack physical dimension	-	Height: 39.5 ft.; Diameter 16"
3. Sampling position	Minimum of 5 diameters (preferably 10) from transition, elbow to assure complete mixing	The distance is 8.0 ft., which is 6.0 stack diameters.
4. Withdrawal points	Duct diameter 30-48": 5	3 withdrawal points
5. Sampling probe configuration	Cannot be readily standardized; should consider deposition losses, ease of removal for cleaning, avoidance of abrupt changes in flow direction to minimize inertial impaction of particles. Probe verticle intake lengths: 5D or greater. (.46") Probe turning radius: 5D or greater (.46") D = orifice diameter Manifold Diameter: $d = \frac{Q}{150} = (.44)$ d= diameter of sample line(cm) Q= sampling rate (cm^3sec)	Sampling probe configuration: Sampling orifice sizes: .092-.093" Vertical intake length: 6" Probe turning radius: 3.75" Probe diameter: = .50"

Table I-L
STACK NUMBER: 287

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
6. Isokinetic Sampling & Sampling Orifices	The velocity at which the sample is withdrawn must be equal to that which exists locally in the stream. Sampling probes (orifices) must be tapered to a knife edge.	The sampling velocity is established at the pitot tube measured velocity at the withdrawal point by varying the size of the orifice as related to the sample rate. Stack velocities are checked frequently. The orifice is drilled to the calculated dia. Redesigned orifices with a knife edge are being ordered and will be installed as they arrive.
7. Sampling line to collector	Optimum Diameter (d)= $\frac{Q^{(2)}}{150}$ = (.44")	0.50"
8. Particle Collectors (Filters)	Consider collecting efficiency, air flow resistance, wet and dry strength, surface roughness, ease of chemical dissolution (when leaching is necessary).	Filter used at NFS: Whatman 41 Collection efficiency: 63% Flow resistance: 26 mm Hg Dry strnegth: Strong Surface roughness: Rough Wet Strength: Reasonably strong Dissolution: Easy

Table I-L
STACK NUMBER: 287

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
9. Filter Support/Holder	Well designed including: (1) Porous backing screen or plate (2) Filter contact surface smooth, flat, free of burrs, etc. (3) Provide a compression sealing ring for air tight seal.(should be tested to assure no leakage) (4) Resistance to corrosion (5) Easily opened and closed	NFS filter holder includes: (1) Backing plate (2) Smooth filter contact surface (3) Rubber "O" ring and teflon base seal. (4) Stainless steel construction (5) Screw type opening
10. Gas washing (Impingers) (inertial collectors)	Considerations: (1) Specific chemical reactions or preferential solubility in liquids may be used. (2) Pass air in fine bubbles through reacting liquid. Air is impinged at high velocity against a gas plate immersed in absorption media. No operating flow is recommended. (3)	NFS System employs: (1) 2 Smith-Greenberg impingers (500 ml) in series, containing a 10% solution of ammonium hydroxide. (2) Efficiency of 90% emperically established.
11. Air Mover (Vacuum Pump) Flow Rate Control	Considerations: (1) Deliver necessary air flow against resistance of sampling system. (2) Maintain constant flow as resistance builds up due to filter loading.	NFS System employs: (1) Positive displacement pump with capacity of 113 lpm a zero pressure drop. Ultimate vacuum:26 in Hg at sea level. (2) A constant flow regulator (variable resistance valve type

Table I-L
STACK NUMBER: 287

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
12. Flow Measuring Device	Flow rate must be measured. Most frequently used is "rotameter." Should be located downstream of collectors.	NFS uses a 0-50 l/m rotameter which is check calibrated to an NBS standard on those stacks which have filters only. For stacks having both filter and impingers a 0-20 l/m rotameter is used. Installed down stream of collectors.

(1) "Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities," American National Standards Institute, Inc. ANSI N13.1, 1969, except as otherwise noted.

(2) "Nuclear Air Cleaning Handbook", U. S. Energy Research and Development Administration (DOE), ERDA 76-21, 1976

(3) "Air Sampling Instruments for Evaluation of Atmospheric Contaminents", 5th Edition, American Conference of Industrial Hygienists, 1978

Table I-M
STACK NUMBER: 332

Table of Comparison
NFS Sampling System to Standards

Item, Function or Consideration	Standard or Other Authority Specification or Comment (1)	NFS Sampling Status
1. Stack air flow characteristics	Air flow is considered turbulant if Reynolds number is >2100	Reynolds number is >2100; therefore, flow is turbulent
2. Stack physical dimension	-	Height: 10 ft.; Dia. 11"x 17"
3. Sampling position	Minimum of 5 diameters (preferably 10) from transition, elbow to assure complete mixing	No acceptable sampling point greater than 5 duct diameters.
4. Withdrawal points	Duct diameter 30-48": 5	1 withdrawal point
5. Sampling probe configuration	Cannot be readily standardized; should consider deposition losses, ease of removal for cleaning, avoidance of abrupt changes in flow direction to minimize inertial impaction of particles. Probe verticle intake lengths: 5D or greater. (2.32") Probe turning radius: 5D or greater (2.32") D = orifice diameter Manifold Diameter: $d = \frac{Q}{150}$ = (1.75") d= diameter of sample line(cm) Q= sampling rate (cm^3sec)	Sampling probe configuration: Sampling orifice sizes: .4646 Vertical intake length: 6" Probe turning radius: 3.75" Probe diameter = 3/8"

Table I-M
STACK NUMBER: 332

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
6. Isokinetic Sampling & Sampling Orifices	The velocity at which the sample is withdrawn must be equal to that which exists locally in the stream. Sampling probes (orifices) must be tapered to a knife edge.	The sampling velocity is established at the pitot tube measured velocity at the withdrawal point by varying the size of the orifice as related to the sample rate. Stack velocities are checked frequently. The orifice is drilled to the calculated dia. Redesigned orifices with a knife edge are being ordered and will be installed as they arrive.
7. Sampling line to collector	Optimum Diameter (d)= $\frac{Q}{150}^{(2)}$ =(1.75")	(.375")
8. Particle Collectors (Filters)	Consider collecting efficiency, air flow resistance, wet and dry strength, surface roughness, ease of chemical dissolution (when leaching is necessary).	Filter used at NFS: Whatman 41 Collection efficiency: 78% Flow resistance: 7 mm Hg Dry strength: Strong Surface roughness: Rough Wet strength: Reasonably strong Dissolution: Easy

Table I-M
STACK NUMBER: 332

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
9. Filter Support/Holder	Well designed including: (1) Porous backing screen or plate (2) Filter contact surface smooth, flat, free of burrs, etc. (3) Provide a compression sealing ring for air tight seal.(should be tested to assure no leakage) (4) Resistance to corrosion (5) Easily opened and closed	NFS filter holder includes: (1) Backing plate (2) Smooth filter contact surface (3) Rubber "O" ring and teflon base seal (4) Stainless steel construction (5) Screw type opening
10. Gas washing (Impingers) (inertial collectors)	Considerations: (1) Specific chemical reactions or preferential solubility in liquids may be used. (2) Pass air in fine bubbles through reacting liquid. Air is impinged at high velocity against a gas plate immersed in absorption media. No operating flow is recommended. (3)	NFS System employs: (1) 2 Smith-Greenberg impingers (500 ml) in series, containin a 10% solution of ammonium hydroxide. (2) Efficiency of 90% emperically established.
11. Air Mover (Vacuum Pump) Flow Rate Control	Considerations: (1) Deliver necessary air flow against resistance of sampling system. (2) Maintain constant flow as resistance builds up due to filter loading.	NFS System employs: (1) Positive displacement pump wi capacity of 113 lpm at zero pressure drop. Ultimate vacuum: 26 in. Hg at sea e (2) A constant flow regulator (variable resistance valve ty

Table I-M
STACK NUMBER: 332

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
12. Flow Measuring Device	Flow rate must be measured. Most frequently used is "rotameter." Should be located downstream of collectors.	NFS uses a 0-50 l/m rotameter which is check calibrated to an NBS standard on those stacks which have filters only. For stacks having both filters and impingers a 0-20 l/m rotameter is used. Installed downstream of collectors.

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(2) "Nuclear Air Cleaning Handbook", U. S. Energy Research and Development Administration (DOE), ERDA 76-21, 1976

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Table I-N
STACK NUMBER: 333

Table of Comparison
NFS Sampling System to Standards

Item, Function or Consideration	Standard or Other Authority Specification or Comment (1)	NFS Sampling Status
1. Stack air flow characteristics	Air flow is considered turbulant if Reynolds number is >2100	Reynolds number is > 2100; therefore, flow is turbulent.
2. Stack physical dimension	-	Height: 14 ft.; Diameter 4"
3. Sampling position	Minimum of 5 diameters (preferably 10) from transition, elbow to assure complete mixing	The distance is 2.0 ft., which is 6.1 stack diameters.
4. Withdrawal points	Duct diameter 30-48": 5	1 withdrawal point
5. Sampling probe configuration	Cannot be readily standardized; should consider deposition losses, ease of removal for cleaning, avoidance of abrupt changes in flow direction to minimize inertial impaction of particles. Probe verticle intake lengths: 5D or greater. (1.27") Probe turning radius: 5D or greater=(1.27") D = orifice diameter Manifold Diameter: $d = \frac{Q}{150} = (1.75")$ d= diameter of sample line(cm) Q= sampling rate (cm^3sec)	Sampling probe configuration: Sampling orifice sizes: .254" Vertical intake length: 6" Probe turning radius: 3.75" Probe diameters: 3/8"

Table I-N
STACK NUMBER: 333

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
6. Isokinetic Sampling & Sampling Orifices	The velocity at which the sample is withdrawn must be equal to that which exists locally in the stream. Sampling probes (orifices) must be tapered to a knife edge.	The sampling velocity is established at the pitot tube measured velocity at the withdrawal point by varying the size of the orifce as related to the sample rate. Stack velocities are checked frequently. The orifice is drilled to the calculated diameter. Redesigned orifices with a knife edge are being ordered and will be installed as they arrive.
7. Sampling line to collector	Optimum Diameter $(d) = \frac{Q}{150} = (1.75")^{(2)}$	.375"
8. Particle Collectors (Filters)	Consider collecting efficiency, air flow resistance, wet and dry strength, surface roughness, ease of chemical dissolution (when leaching is necessary).	Filter used at NFS: Whatman 41 Collection efficiency: 78% Flow resistance: 7 mm Hg Dry strength: Strong Surrface roughness: Rough Wet strength: reasonably strong Dissolution: Easy

Table 1-N
STACK NUMBER: 333

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
9. Filter Support/Holder	Well designed including: (1) Porous backing screen or plate (2) Filter contact surface smooth, flat, free of burrs, etc. (3) Provide a compression sealing ring for air tight seal.(should be tested to assure no leakage) (4) Resistance to corrosion (5) Easily opened and closed	NFS filter holder includes: (1) Backing plate (2) Smooth filter contact surface (3) Rubber "O" ring and teflon bas seal (4) Stainless steel construction (5) Screw type opening.
10. Gas washing (Impingers) (inertial collectors)	Considerations: (1) Specific chemical reactions or preferential solubility in liquids may be used. (2) Pass air in fine bubbles through reacting liquid. Air is impinged at high velocity against a gas plate immersed in absorption media. No operating flow is recommended. (3)	NFS System employs: (1) 2 Smith-Greenberg impingers (500 ml) in series, containing a 10% solution of ammonium hydroxide. (2) Efficiency of 90% emperically established.
11. Air Mover (Vacuum Pump) Flow Rate Control	Considerations: (1) Deliver necessary air flow against resistance of sampling system. (2) Maintain constant flow as resistance builds up due to filter loading.	NFS System employs: (1) Positive displacement pump wit capacity of 113 lpm at zero pressure drop. Ultimate va[illegible]um 26 in. Hg at sea level. (2) A constant flow regulator (variable resistance valve typ

Table I-N
STACK NUMBER: 333

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
12. Flow Measuring Device	Flow rate must be measured. Most frequently used is "rotameter." Should be located downstream of collectors.	NFS uses a 0-50 l/m rotameter which is check calibrated to an NBS standard on those stacks which have filters only. For stacks having both filters and impingers a 0-20 l/m rotameter is used. Installed downstream of collectors.

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(2) "Nuclear Air Cleaning Handbook", U. S. Energy Research and Development Administration (DOE), ERDA 76-21, 1976

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Table I-0
STACK NUMBER:334

Table of Comparison
NFS Sampling System to Standards

Item, Function or Consideration	Standard or Other Authority Specification or Comment (1)	NFS Sampling Status
1. Stack air flow characteristics	Air flow is considered turbulant if Reynolds number is >2100	Reynolds number is >2100 therefore, flow is turbulent
2. Stack physical dimension	-	Height: 24 ft; Dia. 30"
3. Sampling position	Minimum of 5 diameters (preferably 10) from transition, elbow to assure complete mixing	The distance is 14 ft., which is ! stack diameters.
4. Withdrawal points	Duct diameter 30-48": 5	5 withdrawal points
5. Sampling probe configuration	Cannot be readily standardized; should consider deposition losses, ease of removal for cleaning, avoidance of abrupt changes in flow direction to minimize inertial impaction of particles. Probe verticle intake lengths: 5D or greater.= (.388") Probe turning radius: 5D or greater=(.388") D = orifice diameter Manifold Diameter: $d = \frac{Q}{150} = .44"$ d= diameter of sample line(cm) Q= sampling rate (cm^3sec)	Sampling probe configuration Sampling orifice sizes: .075-.080' Vertical intake length: 6" Probe turning radius: 3.75" Probe diameter: = 0.50"

Table I-0
STACK NUMBER: 334

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
6. Isokinetic Sampling & Sampling Orifices	The velocity at which the sample is withdrawn must be equal to that which exists locally in the stream. Sampling probes (orifices) must be tapered to a knife edge.	The sampling velocity is established at the pitot tube measured velocity at the withdrawal point by varying the size of the orifice as related to the sample rate. Stack velocities are checked frequently. The orifice is drilled to the calculated dia. Redesigned orifices with a knife edge are being ordered and will be installed as they arrive.
7. Sampling line to collector	Optimum Diameter (d)= $\frac{Q^{(2)}}{150}$ =(.44")	.50"
8. Particle Collectors (Filters)	Consider collecting efficiency, air flow resistance, wet and dry strength, surface roughness, ease of chemical dissolution (when leaching is necessary).	Filter used at NFS: Whatman 41 Collection efficiency: 63% Flow resistance: 26 mm Hg Dry strength: Strong Surface roughness: Rough Wet Strength: Reasonably strong Dissolution: Easy

Table I-0
STACK NUMBER: 334

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
9. Filter Support/Holder	Well designed including: (1) Porous backing screen or plate (2) Filter contact surface smooth, flat, free of burrs, etc. (3) Provide a compression sealing ring for air tight seal.(should be tested to assure no leakage) (4) Resistance to corrosion (5) Easily opened and closed	NFS filter holder includes: (1) Backing plate (2) Smooth filter contact surface (3) Rubber "O" ring and teflon base seal (4) Stainless steel construction (5) Screw type opening
10. Gas washing (Impingers) (inertial collectors)	Considerations: (1) Specific chemical reactions or preferential solubility in liquids may be used. (2) Pass air in fine bubbles through reacting liquid. Air is impinged at high velocity against a gas plate immersed in absorption media. No operating flow is recommended. (3)	NFS System employs: (1) 2 Smith-Greenberg impingers (500 ml) in series, containing a 10% solution of ammonium hydroxide. (2) Efficiency of 90% emperically established.
11. Air Mover (Vacuum Pump) Flow Rate Control	Considerations: (1) Deliver necessary air flow against resistance of sampling system. (2) Maintain constant flow as resistance builds up due to filter loading.	NFS System employes: (1) Positive displacement pump wit capacity of 113 lpm at zero pressure drop. Ultimate vacuum 26 in. Hg at sea level. (2) A constant flow regulator (variable resistance valve typ

Table I-0
STACK NUMBER: 334

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
12. Flow Measuring Device	Flow rate must be measured. Most frequently used is "rotameter." Should be located downstream of collectors.	NFS uses a 0-50 l/m rotameter which is check calibrated to an NBS standard on those stacks which have filters only. For stacks having both filters and impingers a 0-20 l/m rotameter is used. Installed downstream of collectors.

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(2) "Nuclear Air Cleaning Handbook", U. S. Energy Research and Development Administration (DOE), ERDA 76-21, 1976

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Table 1-P
STACK NUMBER: 354

Table of Comparison
NFS Sampling System to Standards

Item, Function or Consideration	Standard or Other Authority Specification or Comment (1)	NFS Sampling Status
1. Stack air flow characteristics	Air flow is considered turbulant if Reynolds number is >2100	Reynolds number is >2100; therefore flow is turbulent.
2. Stack physical dimension	-	Height: 15.6 ft.; Dia. 12"
3. Sampling position	Minimum of 5 diameters (preferably 10) from transition, elbow to assure complete mixing	The distance is 4.5 ft., which is 4.5 stack diameters.
4. Withdrawal points	Duct diameter 30-48": 5	2 withdrawal points
5. Sampling probe configuration	Cannot be readily standardized; should consider deposition losses, ease of removal for cleaning, avoidance of abrupt changes in flow direction to minimize inertial impaction of particles. Probe verticle intake lengths: 5D or greater. = (1.30") Probe turning radius: 5D or greater (1.30") D = orifice diameter Manifold Diameter: $d = \frac{Q}{150} = 1.75"$ d= diameter of sample line(cm) Q= sampling rate (cm^3sec)	Sampling probe configuration: Sampling orifice sizes: .276" Vertical intake length: 6" Probe turning radius: 3.75" Probe diameter: = 3/8"

Table I-P
STACK NUMBER: 354

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
6. Isokinetic Sampling & Sampling Orifices	The velocity at which the sample is withdrawn must be equal to that which exists locally in the stream. Sampling probes (orifices) must be tapered to a knife edge.	The sampling velocity is establishe at the pitot tube measured velocity at the withdrawal point by varying the size of the orifcie as related to the sample rate. Stack velocitie are checked frequently. The orifice is drilled to the calculated dia. Redesigned orifices with a knife edg are being ordered and will be installed as they arrive.
7. Sampling line to collector	Optimum Diameter (d)= $\frac{Q^{(2)}}{150}$ = (1.75")	.375"
8. Particle Collectors (Filters)	Consider collecting efficiency, air flow resistance, wet and dry strength, surface roughness, ease of chemical dissolution (when leaching is necessary).	Filter used at NFS: Whatman 41 Collection efficiency: 78% Flow resistance: 7 mm Hg Dry strength: Strong Surface Roughness: Rough Wet strength: Reasonably stron Dissolution: Easy

Table I-P
STACK NUMBER: 354

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
9. Filter Support/Holder	Well designed including: (1) Porous backing screen or plate (2) Filter contact surface smooth, flat, free of burrs, etc. (3) Provide a compression sealing ring for air tight seal.(should be tested to assure no leakage) (4) Resistance to corrosion (5) Easily opened and closed	NFS filter holder includes: (1) Backing plate (2) Smooth filter contact surface (3) Rubber "O" ring and teflon base seal (4) Stainless steel construction (5) Screw type opening
10. Gas washing (Impingers) (inertial collectors)	Considerations: (1) Specific chemical reactions or preferential solubility in liquids may be used. (2) Pass air in fine bubbles through reacting liquid. Air is impinged at high velocity against a gas plate immersed in absorption media. No operating flow is recommended. (3)	NFS System employs: (1) 2 Smith-Greenberg impingers (500 ml) in series, containing a 10% solution of ammonium hydroxide. (2) Efficiency of 90% emperically established
11. Air Mover (Vacuum Pump) Flow Rate Control	Considerations: (1) Deliver necessary air flow against resistance of sampling system. (2) Maintain constant flow as resistance builds up due to filter loading.	NFS System employs: (1) Positive displacement pump wit capacity of 113 lpm at zero pressure drop. Ultimate v- ·um 26 in Hg at sea level. (2) A constant flow regulator (variable resistance valve typ

STACK NUMBER 354

Item, Function or Consideration	Standard or Other Authority Specification or Comment	NFS Sampling Status
12. Flow Measuring Device	Flow rate must be measured. Most frequently used is "rotameter." Should be located downstream of collectors.	NFS uses a 0-50 l/m rotameter whic is check calibrated to an NBS star dard on those stacks which have filters only. For stacks having both filters and impingers a 0-20 l/m rotameter is used. Installed downstream of collectors.

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TABLE - II
NFS-STACK DATA
FOR 1980

BLDG. NO.	STACK NO.	ELEMENT	ENRICH. U-235	AIR CLEANING STAGES	1980 DISCHARGE AVG. ($\mu Ci/ml \times 10^{-12}$)	REMARKS
234	27	Pu	N.A.	Triple HEPA Filters	0.09	Building not operating
234	28	Pu	N.A.	Double HEPA Filters	0.07	Building not operating
234	29	Pu	N.A.	Double HEPA Filters	0.07	Building not operating
234	224	Pu	N.A.	Triple HEPA Filters	0.05	Building not operating
234	36	^{233}U	N.A.	HEPA Filter	1.25	Operation is being de-commissioned
110	103(1)	^{235}U	$\leq$5%	Double HEPA Filter	0.75	Storage only
110	104(1)	^{235}U	$\leq$5%	Double HEPA Filter	0.76	Storage only
131	185	^{235}U	>90%	HEPA Filter	0.68	[redacted]
233	253	^{235}U	>90%	Double HEPA Filter	7.57	[redacted]
302	317	^{235}U	>90%	Venturi Scrubber	6.00	[redacted]
111	278	^{235}U	$\leq$5%	Venturi Scrubber	31.08	[redacted]
111	287(I)				18.05	[redacted]
111	287(S)	^{235}U	$\leq$5%	Packed Bed Scrubber	54.95	[redacted]
120	332	^{235}U	>90%	HEPA Filter	1.57	Maintenance Bldg.
110	333	^{235}U	>90	HEPA Filter	0.72	Uranium Spectrographic Lab
105	334(I)				2.80	
105	334(S)	^{235}U	>90%	Packed Bed Scrubber	9.49	Laboratories
110	354	^{235}U	<5%	HEPA Filter	0.56	Trash compactor

Insoluble = (I)

Soluble = (S)

(1) Traces of Thorium and Plutonium are also present

TABLE III

List of Stack Discrepancies
and Their Corrective Actions

Stack No.	Discrepancy	Corrective Action	Estimated Date for Corrective Action
All	Knife edge probes diameter of the probe and sampling line to collector	Install knife edge probe. Reduce flow from 40 to 10 lpm and use .5" dia. sampling probe and line.	May 15, 1981
27, 28 & 36	Stacks too short	Building is no longer in operation; scheduled for decommissioning; therefore, no corrective action is recommended	N. A.
332	Stack too short	Add 7 ft. stack	May 15, 1981
354	Stack too short	This is short by .5 ft. The probability of release from this stack is slight. It is used infrequently; therefore, adding more height is not deemed necessary.	N. A.
185	Stack too short	Add 4 ft. stack	May 15, 1981