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TN-RW-101/00-NP

TN-220

RADIOACTIVE WASTE VOLUME REDUCTION SYSTEM

TOPICAL REPORT

DECEMBER 1980

Prepared for:
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Division of Reactor Licensing
United States Nuclear Regulatory Commission
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Proprietary information has been deleted from this report and is included in the proprietary version, Topical Report No. TN-RW-101/00-P. The proprietary information deleted from this report is Appendix B, TN-220 P&ID and functional description.

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ABSTRACT

This Topical Report describes the design and operation of the Transnuclear, Inc. TN-220 Radwaste Incineration System. The TN-220 is an excess air incineration system for processing combustible low-level radioactive waste. The incinerator reduces the volume of these wastes by a factor of from 60 to 1 up to 100 to 1 and concentrates the radioactivity in the ashes. The ashes are a powdery inert residue which can be solidified in a variety of agents.

This report provides a detailed description of the TN-220 System and describes the extensive operating experience which the TN-220 type systems have accumulated around the world. The report concludes with a section on accident analysis.

The following conclusions about the TN-220 Radwaste Incineration System have been reached:

1) the TN-220 System provides a safe, energy-efficient process for volume reduction of combustible low-level radwaste,

2) the ashes are inert and suitable for solidification in many agents,

3) the decontamination factors have been measured upstream of the HEPA filters at 4.1×10^4 for alpha emitting isotopes and 5.3×10^2 for beta emitting isotopes, and

4) the annual releases of radioactivity are much less than allowed by federal regulations.

The TN-220 System meets all Federal regulations for installation and operation at a nuclear power plant.

1.0 INTRODUCTION

The increasing costs for transportation and burial and more importantly the decreasing allocations of burial space for low-level radioactive wastes requires generators of these wastes to reduce to the maximum extent practicable the volumes generated and shipped offsite. This necessity for volume reduction indicated a need for a proven and reliable cost-effective method for volume reduction of combustible low-level radwaste such as the TN-220 Radwaste Incineration System. Similar systems are in operation around the world at various nuclear power plants and research centers. The original system developed and installed at the Karlsruhe Research Center in West Germany has been in operation over 25,000 hours during the last ten years.

This topical report describes the design and operation of the TN-220 Radwaste Incineration System. The TN-220 is an excess air incineration system for processing combustible low-level radwaste. These wastes include paper, wood, textiles, plastics and combustible fluids which are contaminated as a result of nuclear power plant operation and maintenance activities.

The incineration system consists of a furnace, filters and fans and associated feed, ash removal and control elements. The furnace is a steel shell lined with refractory bricks forming a vertical shaft chamber in which the wastes are incinerated. The offgas is cleaned by two sets of ceramic filters in series at high temperatures followed by one bank of HEPA filters and is exhausted by induced draft fans to a stack. The ashes can be solidified in a variety of agents for interim storage or burial.

The long operating histories of the TN-220 type systems now installed at many locations provide substantial confidence that allowable release specifications will be met and that occupational exposures will be kept to a minimum.

The purpose of this report is to present the necessary data for evaluation of the TN-220 System by the Nuclear Regulatory Commiscion and other interested regulatory agencies.

2.0 PROCESS DESCRIPTION

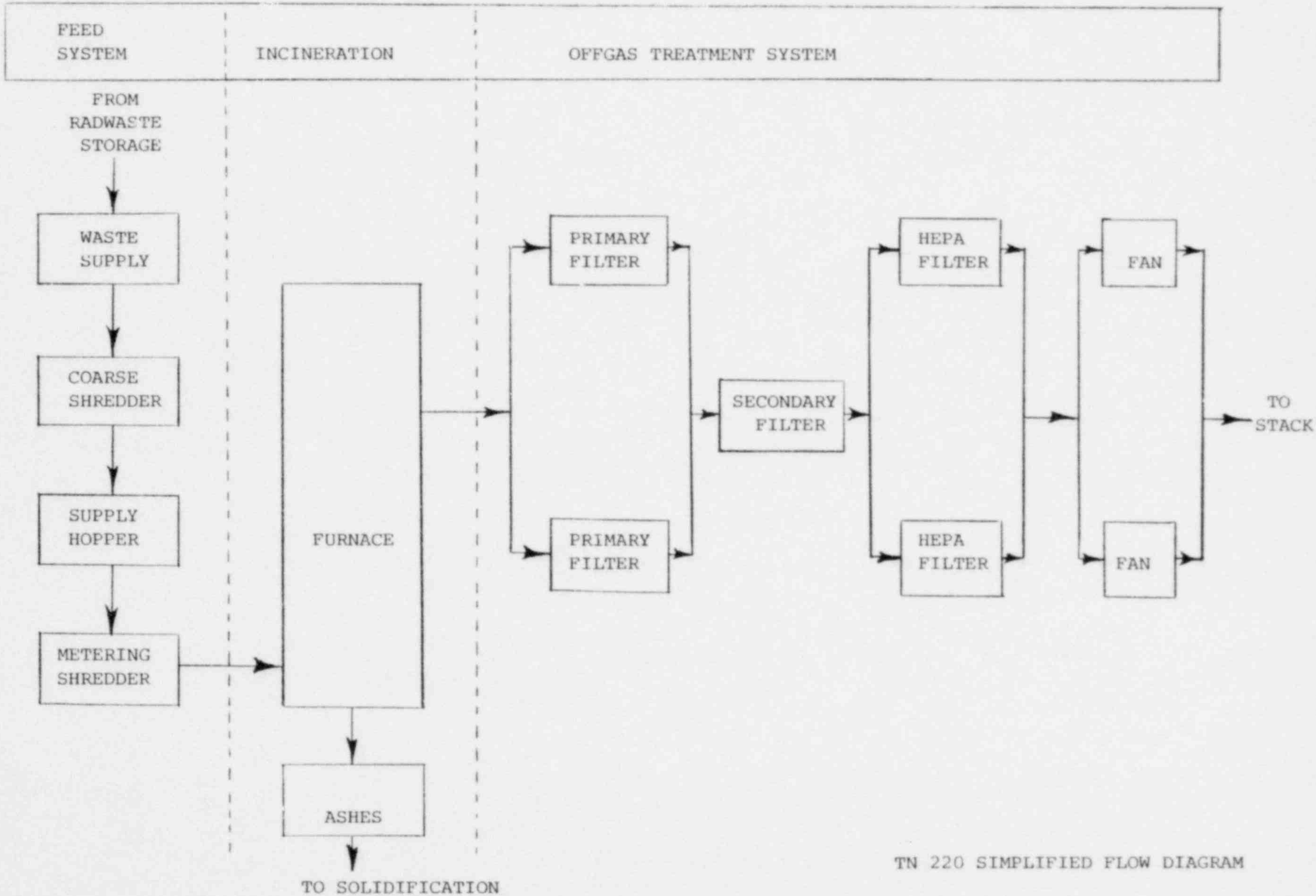
The major components of a TN-220 Radwaste Incineration System are shown in a simplified flow diagram on Figure 2.1.

2.1 FEEDING AND COARSE SHREDDING

Waste in 55 gallon drums is brought to the feed area located on the operating floor by the freight elevator. The drum lid is removed by an operator and is replaced by a sliding lid which limits the spread of contamination and prevents the waste from falling out while the drum is lifted and turned over. The drum with the sliding lid attached is positioned in a lifting and tilting device which grabs the drum, lifts and turns it over, mating the top of the drum to the top of the waste supply and sorting box. The sliding lids on both the drum and the box are opened allowing the waste to fall through the box into the tools of the first shredder. The material coming out of this shredder is coarsely shredded and fills the supply hopper.

2.2 FEED METERING

The amount of waste fed into the furnace is controlled by continuous processing of the waste in the supply hopper. This coarsely shredded waste falls into the tools of a second shredder at the bottom of the supply hopper. The rotational speed of the tools of this second shredder is controlled by the furnace temperature and determines the rate at which the waste is fed into the furnace. The second shredder is equipped with a grate at its outlet which limits the size of the waste fed into the furnace to an appropriate size for burning.



TN 220 SIMPLIFIED FLOW DIAGRAM

Figure 2.1

2.3 AIR SUPPLY

The incineration air supply is drawn into the furnace by an induced draft fan of sufficient capacity to guarantee an excess supply of oxygen for complete oxidation of the waste offgas and char. The airflow is distributed into the furnace chamber through three air inlets to assure proper combustion conditions.

2.4 AUXILIARY BURNER

An auxiliary burner which operates on oil or contaminated combustible liquids is used to preheat the furnace refractory to the proper process startup temperature of about 1200°F.

2.5 INCINERATION

The shredded waste passing through the outlet grate of the second shredder falls into a funnel, through the waste supply isolation valve and into an air conveyor tube to the furnace. The waste conveyed by the incineration air rapidly decomposes upon entering the turbulent flames in the furnace chamber. The pyrolysis offgas is oxidized while exiting toward the top of the furnace chamber and the char is collected in the bottom of the chamber where the burnout is completed.

2.6 OFFGAS TEMPERATURE CONTROL

The oxidized offgas leaving near the top of the furnace chamber is kept below 1800°F by the addition of water in a fine spray.

2.7 PRIMARY FILTER

The offgas leaving the furnace is routed to one of two parallel primary filters which act as afterburners where particulates in the offgas stream are removed. The offgas at a design temperature of 1650°F is drawn by the induced draft fan through glowing-hot porous sintered silicon carbide filters. The particulates are caught and completely oxidized on the outside surface of the filter elements.

2.8 SECONDARY FILTER INLET TEMPERATURE CONTROL

The offgas leaves the primary filter at about 1600°F and is cooled to below 900°F in the offgas piping before entering the secondary filter. The cooling is accomplished by the addition of atomized water sprayed into the offgas stream through a nozzle.

2.9 SECONDARY FILTER

The offgas entering the secondary filter at below 900°F is cool enough to allow removal of radioisotopes which are volatile at the 1650°F temperature in the primary filter. Besides trapping these radionuclides, the secondary filter also acts as a backup to the primary filter should a defective primary filter element allow any particulates to escape.

2.10 CERAMIC FILTER PRESSURE DROP CONTROL

Both the primary and secondary ceramic filter candles will be coated with particulates burnt to ashes on their outside surface. As this coating is built up the pressure drop across the filters will increase.

This pressure drop can be decreased and the candles useful life correspondingly increased by backflushing the candles with compressed air which removes the layer of ash. Use of a portable glove box and an induced draft fan during backflushing maintains a negative pressure in the system and prevents the spread of contamination.

2.11 HEPA FILTER INLET TEMPERATURE CONTROL

The offgas leaves the secondary filter at about 850°F and is cooled to below 400°F before it enters the HEPA filters. The offgas is cooled by the addition of compressed-air atomized water sprayed into the offgas stream in a mixing nozzle in the piping.

2.12 HEPA FILTER

The offgas exhausts through one of two parallel HEPA filters with the other as backup. The HEPA filters are provided to gain an additional measure of decontamination of the already twice filtered offgas.

2.13 INDUCED DRAFT FAN

The offgas is drawn through the incinerator and filtration system by one of two induced draft fans which exhausts to the stack while the other serves as a backup. The entire system operates at a slight negative pressure downstream of the fans and at a slight positive pressure upstream of them.

2.14 OPTIONAL WET SCRUBBER SYSTEM

If the waste to be incinerated contains PVC, removal of the HCl released during combustion can be accomplished by an optional wet scrubber system which neutralizes the HCl with NaOH.

2.15 INSTRUMENTATION AND CONTROLS

The TN-220 System is equipped with instrumentation allowing remote operation from a control panel. Process temperatures, pressures and flowrates are monitored and automatic controls are provided to shut down the system when operating conditions are not within prescribed limits.

2.16 ALARMS AND INTERLOCKS

The TN-220 System is interlocked to assure safe operation and alarms are provided to alert operators to abnormal operating conditions.

2.17 PIPING AND INSTRUMENTATION DIAGRAM

The TN-220 System P&ID is shown in Dwg. SK-1004-00-01 Rev. 2 and discussed in Appendix B.

3.0 PROCESS PARAMETERS

3.1 WASTE DESCRIPTION

The TN-220 Radwaste Incineration System is designed to process combustible dry-solid or liquid low-level radioactive wastes from nuclear power stations. The amounts, chemical compositions and specific activities of the radioactive wastes used in this report are taken from the following sources as shown in the list of references:

1) ERDA 76-43
2) WASH 1258
3) ANSI 55.1-1979
4) NUREG 0521

3.1.1 COMPOSITION

The wastes to be incinerated are either dry-solid or liquid, combustible low-level radioactive wastes.

The dry-solid combustible wastes from nuclear power plants consist mostly of clothing (protective suits), cleaning rags and polyethylene packing material. There are also small amounts of paper, polyvinyl chloride, rubber and wood. The heat value of these wastes range from 6000 to 10,000 Btu/lb with small amounts of waste having heat values as high as 20,000 Btu/lb. Average heat values ranging from 7500 to 9500 Btu/lb of waste are assumed in this report.

The liquid combustible waste from nuclear power plants consists mostly of lubricating oils which have been contaminated. The average heat value of these liquids is 20,000 Btu/lb.

See Table 3-1 for a summary of the waste characteristics.

3.1.2 AMOUNTS

The yearly throughput of waste depends on hours of operation and heat value per pound. Based on a design thermal capacity of 2 x 10^6 Btu/hr, and assuming an average heat value of 9000 Btu/lb the nominal throughput is approximately 220 lb/hr.

The design operating availability is 6440 hour/year which allows the incineration of 1.4 x 10^6 lb of average heat value waste per year.

The yearly amounts of waste as reported in references 1 to 3 are shown on Table 3-2 for BWRs and Table 3-3 for PWRs. WASH 1258 expected the maximum yearly amount to be 148,500 lbs per 3500 MWt reactor unit.

The actual yearly quantity from any site depends upon many factors such as size and age of plant, extent of outages and housekeeping practices. The variation in yearly quantities between reactor sites and between years for a given site is available from reference 4. This reference shows that the 148,500 lbs per unit per year is too low in some cases.

Because of the variability of annual waste quantities the TN-220 is considered adequate to process the wastes from reactor sites with up to 3 or even 4 units.

3.1.3 SPECIFIC ACTIVITY

The TN-220 is designed to handle only low-level radwaste. From Tables 3-2 and 3-3 the highest specific activity given is 0.6 x 10^{-4} Ci/lb. The design of the TN-220 is based on a conservative 2 x 10^{-4} Ci/lb.

The nuclide composition is assumed to be the same as the combustible radwaste from WASH 1258 as shown in Table 3-4 for PWRs and BWRs.

Neither radioactive iodine nor tritium are present in significant amounts in the combustible radwaste. Additional safeguards for containment of these nuclides are therefore not required. All significant nuclides are either not volatile or only slightly so, and are easily retained by the filtration system.

3.2 INCINERATION PRODUCTS

The combustible radwaste is incinerated to yield offgas and ashes. The ashes, along with the filter candles which become a secondary waste, are solidified in drums for subsequent storage or burial.

3.2.1 ASHES AND FILTER CANDLES

The ashes contain all of the non-volatile radionuclides after combustion. Any particulates which carry radionuclides out of the furnace are afterburned in the primary filter on the outside surface of the filter candles. Together the ashes and filter candles contain practically the entire activity of the input wastes.

While a weight reduction of 20 to 1 is attained by incineration, a volume reduction of 80 to 1 has been attained during nearly ten years of operation at the Nuclear Research Center in Karlsruhe, West Germany. When secondary waste and subsequent solidification are included, the overall system volume reduction factor is in the range of 40 to 1 up to 60 to 1.

3.2.2 OFFGAS

The TN-220 is an excess air type of incineration system with a design excess air factor of 1.7 which assures an oxygen rich combustion zone for complete burning of the radwaste. The use of continuous waste feeding, together with the excess air delivered from three separate air inlets, assures rapid pyrolysis and complete combustion during steady state operation. This operating mode avoids formation of carbon monoxide and soot. Depending on the composition of the waste, the offgas will contain N_2, O_2, CO_2 and H_2O with trace amounts of NO_x, SO_x and HCl.

The offgas released to the stack is about 1500 actual cubic feet per minute. After release from the stack the offgas is highly diluted with air from atmospheric dispersion.

3.3 RADIOACTIVE RELEASES IN THE OFFGAS

Radioactivity in the offgas enters the environment around the site. From the specific activity and nuclide percentages assumed in the input waste stream, the radionuclide concentration in the offgas after the filters at the site boundary can be calculated. In this calculation a decontamination factor of 2.1×10^4 for all nuclides, and a dispersion coefficient of 5×10^{-6} s/m^3 was used. For the purposes of the radioactive release calculations,the waste throughput is conservatively assumed to be 264 lb/hr.

Tables 3-5 and 3-6 show the calculated nuclide concentrations in the offgas exhaust and at the site boundary for BWR and PWR wastes respectively.

The tables show the concentrations at the site boundary are orders of magnitude below the allowable values per 10CFR20.

Using the above assumptions and a throughput of 264 lb/hr for 6440 hr/yr the expected releases are less than 1.8×10^{-2} Ci/yr for BWRs and for PWRs.

Table 3-1

COMBUSTIBLE WASTE CHARACTERISTICS

Composition:		Miscellaneous combustible solid wastes including rags, clothing, wood, paper, rubber, plastics, polyethylene, polypropylene and polyvinyl chlorides. Miscellaneous combustible liquid wastes such as lubricating oils.	
Density of Solids:		10 lb/ft^3	160 kg/m^3
Heat Value:	Average	6000 to 10,000 Btu/lb	14,000 to 23,000 kJ/kg
	Maximum	20,000 Btu/lb	46,500 kJ/kg

Table 3-2

COMBUSTIBLE DRY WASTE FROM BWR NUCLEAR POWER STATIONS

	Per WASH 1258		Per ERDA 76-43		Per ANS 55.1	
	U.S.	Metric	U.S.	Metric	U.S.	Metric
Volume per year	5300 ft^3	150 m^3	9900 ft^3	280 m^3	10,600 ft^3	300 m^3
Average Density	28 lb/ft^3	450 $\frac{kg}{m^3}$	9.3 lb/ft^3	150 $\frac{kg}{m^3}$	9.3 lb/ft^3	150 $\frac{kg}{m^3}$
Weight per year	148,500 lb	67,500 kg	92,400 lb	42,000 kg	99,000 lb	42,500 kg
Total Activity	<5 Ci	<5 Ci	<5 Ci	<5 Ci	not given	not given
Specific Activity	$<0.3 \times 10^{-4}$ Ci/lb	$<0.7 \times 10^{-4}$ Ci/kg	$<0.5 \times 10^{-4}$ Ci/lb	$<1.2 \times 10^{-4}$ Ci/kg	not given	not given

Table 3-3

COMBUSTIBLE DRY WASTE FROM PWR NUCLEAR POWER STATIONS

	Per WASH 1258		Per ERDA 76-34		Per ANS 55.1	
	U.S.		U.S.	Metric	U.S.	Metric
Volume per year	3500 ft^3	100 m^3	8100 ft^3	230 m^3	10,600 ft^3	300 m^3
Average Density	28 lb/ft^3	450 $\frac{kg}{m^3}$	9.3 lb/ft^3	150 $\frac{kg}{m^3}$	9.3 lb/ft^3	150 $\frac{kg}{m^3}$
Weight per year	99,000 lb	45,000 kg	75,900 lb	34,500 kg	99,000 lb	45,000 kg
Total Activity	$<$ 5 Ci	$<$ 5 Ci	$<$ 5 Ci	$\leq$5 Ci	not given	not given
Specific Activity	$<$ 0.5×10^{-4} Ci/lb	$<$ 1.1×10^{-4} Ci/lb	$<$ 0.6×10^{-4} Ci/lb	$<$ 1.4×10^{-4} Ci/lb	not given	not given

Table 3-4

NUCLIDE COMPOSITION OF THE COMBUSTIBLE

RADIOACTIVE WASTE PER WASH-1258 AFTER 180 DAY DECAY

BWR	Nuclide	Percentage
	Mn-54	1%
	Fe-55	50%
	Co-58	8%
	Co-60	13%
	Sr-89	3%
	Sr-90	6%
	Cs-134	8%
	Cs-137	8%

PWR	Nuclide	Percentage
	Mn-54	1%
	Fe-55	3%
	Co-58	2%
	Co-60	5%
	Cs-134	46%
	Cs-137	44%

The remaining nuclides have a proportion of less than 0.5%.

Table 3-5

BWR NUCLIDE CONCENTRATION IN THE OFFGAS EXHAUST AND AT THE SITE BOUNDARY

NUCLIDE	NUCLIDE RELEASES	OFFGAS CONCENTRATION	SITE BOUNDARY CONCENTRATION	MPC 10 CFR 20 APPENDIX B
	$\frac{pCi}{sec}$	$\frac{pCi}{m^3}$	$\frac{pCi}{m^3}$	$\frac{pCi}{m^3}$
Mn-54	7	10	3.5×10^{-5}	1,000
Fe-55	350	500	1.7×10^{-3}	30,000
Co-58	56	80	2.8×10^{-4}	2,000
Co-60	91	130	4.5×10^{-4}	300
Sr-89	21	30	1.0×10^{-4}	300
Sr-90	42	60	2.1×10^{-4}	30
Cs-134	56	80	2.8×10^{-4}	400
Cs-137	56	80	2.8×10^{-4}	500

Assuming: A) 2×10^{-4} Ci/lb specific activity of waste

B) Nuclide composition per Table 3-3

C) Decontamination factor of 21,000

D) Dispersion coefficient equal to 5×10^{-6} Sec/m^3

Table 3-6

PWR NUCLIDE CONCENTRATION IN THE OFFGAS EXHAUST AND AT THE SITE BOUNDARY

Nuclide	Nuclide Releases	Offgas Concentration	Site Boundary Concentration	MPC 10CFR20 Appendix B
	$\frac{pCi}{sec}$	$\frac{pCi}{m^3}$	$\frac{pCi}{m^3}$	$\frac{pCi}{m^3}$
Mn-54	7	10	3.5×10^{-5}	1,000
Fe-55	21	30	1.1×10^{-4}	30,000
Co-58	14	20	7.0×10^{-5}	2,000
Co-60	35	50	1.8×10^{-4}	300
Cs-134	321	460	1.6×10^{-3}	400
Cs-137	307	440	1.5×10^{-3}	500

Assuming: A) 2×10^{-4} Ci/lb specific activity of waste

B) Nuclide composition per Table 3-4

C) Decontamination factor of 21,000

D) Dispersion coefficient equal to 5×10^{-6} sec/m^3

4.0 EQUIPMENT DESCRIPTION

The TN-220 Radwaste Incineration System components and subsystems are briefly described in the following sections:

4.1 SHREDDING AND FEED SYSTEM

The shredding and feed system consists of a sliding lid to attach to the drum before emptying, a lifting and tilting device, a supply and sorting box, a shredder for coarse cutting, a storage hopper which accepts the coarsely shredded waste, a second shredder with sieve, a funnel, a feed system isolation valve and an air conveyor duct through which the waste is drawn into the furnace. This system guarantees an appropriate size reduction of the waste for burning and provides continuous feed to the furnace.

This system is equipped with an exhaust duct, exhaust duct isolation valve, filter and fan for removing dust created by shredding. Separate detectors monitor for flames and smoke in the storage hopper. When a fire is detected the isolation valves close to isolate the shredding and feed system and a Halon fire extinguishing system is actuated which releases a bottle of Halon into the feed system extinguishing the fire.

4.2 FURNACE

The furnace is a vertical shaft design incineration chamber consisting of a supporting steel shell and several inside layers of refractory bricks. The steel outer shell provides an easily decontaminable surface and the inside ceramic surface is resistant to high temperatures and attack by corrosion.

4.3 PREHEATER/AUXILIARY BURNER

An oil burner located near the bottom of the furnace preheats the furnace refractory during startup. This burner can also be used as an auxiliary burner for incineration of combustible radwaste liquids.

4.4 OFFGAS FILTER

The offgas is filtered in a dry system at a high temperature. The dry filter system consists of two parallel primary filters and one secondary filter which are all of identical construction. The filter housings are steel shells lined with refractory bricks. The two primary filters are in parallel, but during operation only one is connected in series with the secondary filter. The other primary filter serves as a standby unit and increases the availability of the overall system when maintenance of one is necessary.

4.5 FILTER CANDLES

The TN-220 uses porous high temperature resistant sintered silicon carbide filter elements called candles to filter the offgas. Each candle is a hollow tube closed at one end. The offgas goes through the outside surface into the hollow center and out through the open end.

4.6 FILTER CANDLE SUPPORT PLATE

Each filter housing contains two circular steel plates which each support 61 filter candles. These plates are made of high temperature resistant steel to be able to withstand the hot offgas environment.

4.7 PORTABLE FILTER CHANGING BOX

To backflush the filter candles and extend their service life or to change the filter candles at the end of their useful service life, the lid on the filter housing is removed and replaced with a portable glove box. This box permits backflushing and old candle removal and new candle insertion to be performed without airborne contamination problems.

4.8 HOT OFFGAS VALVES

The two primary filter housings are equipped with hot offgas valves which can be used to isolate a primary filter for backflushing or replacement of the filter candles during continued operation of the system. The valves are made of a steel shell with refractory lining and have a seat and plug made of high temperature resistant material.

4.9 PRESSURE CONTROL VALVES

The pressure control valves are for safety in the event any material introduced into the furnace causes an overpressure in the system.

4.10 OFFGAS PIPING

The offgas piping is made up of standardized straight length and T-shaped pieces. Each piping piece has a steel shell and refractory lining.

4.11 MIXING NOZZLE

The offgas piping has mixing nozzles used to cool the offgas before the secondary filter and the HEPA filters. Cooling water is added to the offgas in the mixing nozzles.

4.12 HEPA FILTER AND FANS

The TN-220 includes two high efficiency particulate absolute (HEPA) filters connected in parallel and two induced draft fans downstream of the HEPAs also in parallel. Only one HEPA and one fan are used during operation with the others as backups. The fan exhausts the offgas to the plant stack and maintains the system at an underpressure relative to ambient.

4.13 ASH REMOVAL BOX

A glove box for removing the ashes is underneath the furnace. A lid on the bottom of the furnace is opened allowing the ashes to fall into the cooling chamber section of the ash removal box. After cooldown the ashes are allowed to fall into an ash storage bin. The storage bin uses a screw feeder to meter the ashes into a mixer which combines the ashes and solidification agent.

4.14 FILTER ELEMENT REMOVAL BOX

Glove boxes for removing the used filter candles are underneath the filter housings. A lid on the bottom of the filter housing is opened allowing the used candles to fall onto a grate in the filter element removal box. The candles are shattered to pieces small enough to fit through the grate and fall into a 55 gallon drum attached to the bottom of the box.

4.15 OPTIONAL OFFGAS SCRUB SYSTEM

Downstream of the secondary filter an optional wet scrub system can be installed for offgas treatment when large quantities of PVC are to be incinerated. The scrub system consists of a jet scrubber which quenches the offgas with a NaOH solution. The offgas/solution mixture then enters a separation column in which the offgas separates from the solution. The offgas continues upward and out of the column passing through moisture separators while the scrub solution is collected at the bottom of the column. Preheated air is added to the offgas to raise the dew point before entering the fan and stack. The scrub solution is cooled in a heat exchanger and batch changed when the salt in solution reaches approximately 22 percent.

5.0 SYSTEM LAYOUT

The TN-220 System allows flexibility in system layout. This permits backfit of this equipment into already existing radwaste buildings. The furnace and filters have no required orientation to each other and can easily be connected in many arrangements.

The existing installations are in buildings designed for the incinerator system and provide a good basis for a recommended layout.

5.1 RECOMMENDED LAYOUT

The system layout as described in the following sections assumes a new building is available for the incinerator system and that some associated radwaste areas are included in the same facility.

The TN-220 system has three different elevations where specific activities are performed. The top or operating floor level has the control panel for supervising operations, the waste feed system for loading the waste and the tops of the filter housings for changing the filter candles. The middle level is for removing used filter candles. The bottom level is for ash removal.

The optional wet scrub system, if installed, would have equipment on all three levels but the equipment requiring attention would be located on the ground level in a separate cubicle.

5.2 WASTE FEED

The waste in the storage area is brought to the operating level of the incineration facility by a freight elevator. The waste is then emptied drum by drum into the waste shredding and supply system.

5.3 ASH REMOVAL

The ashes concentrate the radioactivity which was in the feed and special precautions are taken to assure no accidental releases of the material occur. The ashes leaving the incinerator fall into the cooling section of the ash removal glove box. The ash removal glove box is in a cubicle with the ash storage bin. This cubicle limits access to the ashes and during normal operation no entry is required. The ash storage cubicle is directly above the solidification agent and ash mixer to minimize the chances for accidents while the ashes are unsolidified.

5.4 SPENT FILTER CANDLE REMOVAL

The spent filter candles are broken at the top of the filter housing and fall to the bottom where they shatter and then fall into a 55 gallon drum. The 55 gallon drums are removed from the middle level of the building to the solidification station.

5.5 SCRUB SOLUTION REMOVAL

The wet scrubber system if installed would require the scrub solution to be batch changed. Each batch of scrub solution would be taken to the solidification station or alternatively to the power plant's liquid volume reduction system for processing.

5.6 RADIATION EXPOSURE CONTROL (ALARA)

The extensive operating history of the KfK type systems has been considered in the design of the TN-220 from a radiation exposure control standpoint. The radiation doses from operations are expected to be even lower than that at present facilities due principally to the improvements in the waste feed and ash handling systems.

The intent of ALARA has been incorporated into the TN-220 from the waste feed system to the ash handling and other subsystems and components and their operation and maintenance.

5.7 MAINTENANCE ACCESSIBILITY

The TN-220 System is designed for ease of maintenance accessibility and the resulting minimal exposure of maintenance personnel. The furnace, filters and connecting piping have steel shells with refractory lining. The steel shells are all flanged and bolted together allowing disassembly for replacement of the refractory. A small crane above the operating floor is available for maintenance activities.

5.8 CONTROL PANEL

The control panel is located away from radiation areas to reduce operator exposure. Controls and indicators are provided to allow operation of the TN-220 from the control panel. The control panel is laid out similar to the process flowsheet permitting the operators to see graphically the results of their actions. The interlocks and alarms necessary to protect the operators and equipment during operations are also included in the control panel.

5.9 ELECTRICAL CLASSIFICATION

All wiring shall be in accordance with the National Electric Code and National Fire Protection Agency guidelines.

5.10 SCOPE OF SUPPLY

All equipment necessary for the TN-220 System will be supplied by Transnuclear, Inc. or an equipment manufacturer selected and approved by Transnuclear. This equipment includes waste feed system, furnace, hot offgas piping and filters, HEPA filters, offgas cooling system, induced draft fans and the process controls.

Not included in the scope of supply are the interfaces and utilities which are the responsibility of the purchaser.

5.11 UTILITIES AND INTERFACE REQUIREMENTS

The following utilities are required:

Electricity: Installed Capacity 150kW
Normal Operations Requirement 80 kW

Fuel: Startup uses 5 gallon/hr of fuel oil or contaminated oil

Compressed Air: Offgas Cooling 110 scfm
Instruments 20 scfm

Demineralized Water: Offgas Cooling 130 gallons/hr

The TN-220 interfaces with the plant in the following areas:

Dry Waste Feed Input: 55 gallon drums of low-activity solid dry waste are accepted and loaded individually.

Combustible Liquid Waste Input: An oil storage tank accepts low-activity oils for use as startup fuel.

Solidified Ash Output: 55 gallon drums of solidified ashes are produced.

Offgas Exhaust: 1500 acfm at 17.4 psia and 400^{o}F are discharged.

6.0 COMPLIANCE WITH U.S. REGULATIONS

The TN-220 system will be in compliance with the applicable U.S. regulations during design, fabrication, installation, operation and maintenance. U.S. nuclear power stations do not currently have refractory lined equipment similar to the TN-220 which would serve as a historical basis for guidance in regulatory compliance. However, the long safe operating history of this equipment around the world is assurance that compliance with applicable U.S. nuclear power related regulations and use of the highest quality conventional construction techniques will result in an incinerator system which is licenseable for U.S. nuclear power plant use.

Table 6-1 lists the regulations applicable to the TN-220, the reason the TN-220 is expected to be in compliance with the regulations and the experience at other TN-220 type systems which supports the reasoning that the TN-220 will be in compliance with the U.S. regulations.

TABLE 6-1

U.S. REGULATIONS APPLICABLE TO THE TN-220 SYSTEM

U.S. Regulation	Reason TN-220 is expected to be in compliance during operation and maintenance	Experience at other TN-220 type units which supports expected compliance reasoning
10CFR20.101 Exposure of individuals to radiation in restricted areas	The dose expected per exposure is much less than the allowable dose limits.	Equipment surface dose rates are very low. Highest dose rate is expected during replacement of refractory inside the furnace where one R/hr has been reported. Refractory replacement is expected to occur infrequently. A minimum of 5 years useful service life is expected based on operating experience. Much longer service life is expected based on new refractory linings now in use.
10CFR20.103 Exposure of individuals to concentrations of radioactive materials in air in restricted areas	The expected airborne radionuclide concentrations are much less than the allowable limits. The TN-220 system operates at a negative pressure so leaks are into system. Building ventilation will remove airborne contaminants.	Airborne radionuclide concentrations are very low. Equipment swipe tests show no leakage out of system.
10CFR20.105 Permissible levels of radiation in unrestricted areas	The dose rates expected in unrestricted areas are much less than the allowable limits.	Building housing equipment provides shielding which keeps dose rates in unrestricted areas very low.

U.S. Regulation	Reason TN-220 is expected to be in compliance during operation and maintenance	Experience at other TN-220 type units which supports expected compliance reasoning.
10CFR20.106 Radioactivity in effluents to unrestricted areas	The expected radionuclide concentrations in the offgas are orders of magnitude below the allowable concentration limits.	Offgas filtration equipment provides effective radionuclide removal as evidenced by high decontamination factors which keep releases very low.
10CFR20.305 Treatment or disposal by incineration	An approved TN-220 Topical Report does not exempt NRC licensees from obtaining site specific approval for use. The TN-220 will meet the general intent of this section which is assurance of compliance with 10CFR20.106.	In each country where TN-220 type units are installed similar requirements for a license are being met.
10CFR50 Appendix A Criterion 60 Control of releases of radioactive material to the environment	The releases from operation of the TN-220 are controlled. Radiation monitors will terminate operation if preset release rate limits are reached.	Operation of other TN-220 type installations has not had to have been curtailed because of uncontrolled releases of radioactive material in the offgas.
10CFR50 Appendix A Criterion 61 Fuel storage and handling and radioactivity control	The TN-220 is designed to assure adequate safety under normal and postulated accident conditions. It permits appropriate periodic inspection and is shielded for radiation protection. It operates at a negative pressure for containment and confinement of radionuclides throughout the incineration and filtration system. It also has two fans, one of which is redundant, for removing residual heat from the refractory after operation.	Other TN-220 type installations have operated safely for over 45,000 hrs. Periodic inspection and regular maintenance have been performed and radiation shielding provided where appropriate. The fans contain and confine radionuclides to the system and in these systems there are also two fans, one of which is redundant.

U.S. Regulation	Reason TN-220 is expected to be in compliance during operation and maintenance	Experience at other TN-220 type units which supports expected compliance reasoning
10CFR50 Appendix A Criterion 63 Monitoring fuel and waste storage	Only low-level radwaste is to be processed in the TN-220 which precludes both self-heating and excessive radiation levels of the waste. Abnormal operating conditions are sensed by the equipment and initiate appropriate safety actions.	Other TN-220 type systems process only low-level radwaste. No levels of radiation in excess of those expected from the concentrating of the activity in the ashes have occurred. These systems are also instrumented to initiate appropriate safety actions during abnormal operating conditions.
10CFR50 Appendix A Criterion 64 Monitoring radioactivity releases	During all releases the TN-220 offgas exhaust radioactivity detector monitors the effluents before routing the offgas to the plant's exhaust stack and monitoring system.	All TN-220 type systems monitor offgas releases for radioactivity.
10CFR50 Appendix B Quality Assurance Criterion for Nuclear Power Plants and Fuel Reprocessing Plants	The TN-220 Quality Assurance Program is presented in section 8.0 of this report. The QA program is in compliance with Reg. Guide 1.143.	In each country where TN-220 type systems are installed similar QA requirements appropriate to the country were implemented.

U.S. Regulation	Reason TN-220 is expected to be in compliance during operation and maintenance	Experience at other TN-220 type units which supports expected compliance reasoning
10CFR50 Appendix I Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low As Is Reasonably Achievable" For Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents	The expected radioactive releases are very low. The expected radionuclide concentrations in the off-gas at the site boundary are presented in Tables 3-5 and 3-6 and show the concentrations are orders of magnitude below the allowable concentrations. The expected dose rates will be only a small percentage of the plant's total and will have no appreciable effect on the plant satisfying the Appendix I requirements.	The TN-220 type systems installed in other countries meet the radioactivity release specifications with which they must comply. The releases are very low and have been so during years of operation.
10CFR71 Packaging of Radioactive Materials for Transport and Transportation of Radioactive Materials Under Certain Conditions	The ashes expected from the TN-220 are a powdery inert residue which can be solidified in a variety of agents. The solidified product is expected to qualify as Low Specific Activity material suitable for transport to a burial site for permanent disposal.	The TN-220 type systems installed in other countries produce ashes which have been stored safely for many years. Transports have been in compliance with regulations in effect in each country.
49CFR73.390 Transport groups of radionuclides	The radionuclides present in the solidified ashes will be the same as those in the waste fed to the incinerator. The transport Groups which are expected to apply will be Groups II, III and IV.	Transports have been in compliance with regulations in effect during the transport in each country. Transport Groups may have been applicable. See IAEA regulations below.

U.S. Regulation	Reason TN-220 is expected to be in compliance during operation and maintenance	Experience at other TN-220 type units which supports expected compliance reasoning
49CFR73.392 Low specific activity radioactive material	Solidified ashes produced by the TN-220 are expected to qualify as Low Specific Activity material. Transportation of the waste will be in compliance with the DOT LSA regulations.	Transports have been in compliance with regulations in effect during the transport in each country. LSA material classification may have been applicable. See IAEA regulations below.
49CFR173.397 Contamination Control	Solidified ash drums produced by the TN-220 will be decontaminated in accordance with the regulations of 49CFR173.397.	Ash drum decontamination is per the regulations in effect in each country. See IAEA regulations below.
Regulatory Guide 1.143 Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants.	The TN-220 system will be designed constructed, installed and tested in accordance with this guide.	The TN-220 type systems in other countries are designed, constructed, installed, and tested in accordance with similar regulations in effect in each country.
Regulatory Guide 8.8 Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be As Low As Is Reasonably Achievable.	The TN-220 is designed to ensure that occupational exposures are minimized. The intent of ALARA has been incoprorated into the waste feed, ash handling and other subsystems which have been redesigned.	Occupational exposures at other TN-220 type systems have been decreasing as a result of efforts to comply with the ALARA principle.

U.S. Regulation	Reason TN-220 is expected to be in compliance during operation and maintenance	Experience at other TN-220 type units which supports expected compliance reasoning
IAEA Regulations "Safety Series No. 6, Regulations for the Safe Transport of Radioactive Materials 1973, Revised Edition"	The solidified ashes produced by the TN-220 are expected to qualify as "Low level solid radioactive material" when these regulations are adopted by the DOT. The packaging and transportation of these radioactive materials would then be in accordance with the proposed 49CFR127.	Each country has its regulations for transport of radioactive material and many of them are compatible now with these IAEA regulations. Transports of ashes may already be being performed to the current IAEA regulations.

7.0 CODES AND STANDARDS

In accordance with Regulatory Guide 1.143, the TN-220 will be designed and fabricated using the materials, welder qualification, procedures, inspection and testing specified in Table 1 of the Regulatory Guide as shown in Table 7-1.

Manufacturers standards will be used for hardware which is not listed in Table 7-1. Such hardware includes shredders, fans, refractory and other miscellaneous items.

TABLE 7-1

This table is taken from Regulatory Guide 1.143

TABLE 1
EQUIPMENT CODES

EQUIPMENT	CODES			
	Design and Fabrication	Materials[1]	Welder Qualification and Procedures	Inspection and Testing
Pressure Vessels	AMSE Code Section VIII, Div. 1	ASME Code Section II	ASME Code Section IX	ASME Code Section VIII, Div. 1
Atmospheric Tanks	ASME Code[3] Section III, Class 3, or API 650, or AWWA D-100[2]	ASME Code[2] Section II	ASME Code Section IX	ASME Code[3] Section III, Class 3, or API 650, or AWWA D-100[2]
0-15 PSIG Tanks	ASME Code[3] Section III, Class 3, or API 620[2]	ASME Code[2] Section II	ASME Code Section IX	ASME Code[3] Section III, Class 3, or API 620[2]
Heat Exchangers	ASME Code Section VIII, Div. 1 and TEMA	ASME Code Section II	ASME Code Section IX	ASME Code Section VIII, Div. 1
Piping and Valves	ANSI B31.1	ASTM and ASME Code Section II	ASME Code Section IX	ANSI B31.1
Pumps	Manufacturers' Standards[4]	ASME Code Section II or Manufacturers' Standards	ASME Code Section IX (as required)	ASME Code[3] Section III, Class 3; or Hydraulic Institute

[1]Manufacturers' material certificates of compliance with material specifications may be provided in lieu of certified material.

[2]Fiberglass-reinforced plastic tanks may be used in accordance with appropriate articles of Section 10 of the ASME Boiler and Pressure Vessel Code for applications at ambient temperature.

[3]ASME Code stamp, material traceability, and the quality assurance criteria of Appendix B to 10 CFR Part 50 are not required. Therefore, these components are not classified as ASME Code Class 3.

[4]Manufacturers' standard for the intended service. Hydrotesting should be 1.5 times the design pressure.

8.0 QUALITY ASSURANCE PROGRAM FOR THE TN-220 RADIOACTIVE WASTE MANAGEMENT SYSTEM

Transnuclear establishes and maintains integrated quality assurance programs which govern Transnuclear's safety related activities and those of it's contractors for each area of activity. Transnuclear's Quality Assurance Program for Design and Manufacture of Radioactive Waste Management Systems and Components, E-2348, shall govern safety related activities on radioactive waste management projects. An uncontrolled copy of this QA program is presented in Appendix A.

A specific Project QA Program Plan shall be established and implemented in accordance with E-2348, Section 2.

9.0 OPERATING EXPERIENCE

The TN-220 system is based on research and development work performed at the Karlsruhe Nuclear Research Center (KfK) in West Germany. The pilot plant for volume reduction of solid radioactive waste was started in 1963. The original offgas cleanup system was improved such that by 1970 the cleanup system had evolved to the ceramic filter system in use today. The original full size incinerator with a capacity of 60 kg/hr which started in 1970 is still in operation with over 25,000 hours of radwaste processing. This unit reduced over 300,000 ft^3 of solid waste to less than 4400 ft^3 of ash while operating with an average availability of over 80%.

The outstanding performance of the original KfK unit brought interest from other nuclear facilities in obtaining similar type units. Under a license agreement with KfK the following units were built:

Location	Startup	Hours of Operation
Wuerenlingen Nuclear Research Center, Switzerland	1975	10,000
Tsuruga Nuclear Power Plant, Japan	1977	6,000
Seibersdorf Nuclear Research Center, Austria	1978	4,000
Mihama Nuclear Power Plant, Japan	1978	4,000
Japanese Atomic Research Institute, Japan	1979	2,000

Seven additional units are under construction and five more are planned.

Additional published information on this system is available in references 5 to 9 in Section 12.0.

10.0 RESEARCH AND DEVELOPMENT PROGRAM

10.1 INTRODUCTION

The extensive research and development programs undertaken in the past have been mentioned in Section 9.0. This section will outline some current research and development areas.

10.2 CONTINUOUS FEED SYSTEMS

The original KfK incinerator was not a continuous feed system. Individual bags of waste were fed into the furnace using a sliding air lock system. Handling of each bag of waste was responsible for the majority of the annual occupational exposure. A new continuous feed system similar to that described in this topical report is now in use. Experience gained with this system will be incorporated into future TN-220 systems.

10.3 RESIN INCINERATION

Volume reduction of demineralizer resins is being investigated at the original KfK unit. Low activity resins have been incinerated during the past two years in an attempt to determine an acceptable resin feed system and also to investigate the process parameters for the incineration of various resin types.

10.4 EVAPORATOR BOTTOMS PROCESSING

The ability of the TN-220 to process evaporator bottoms is being investigated. The effect of chemical composition on feed rates and filter performance must be more fully understood before practical application can be made.

10.5 DECONTAMINATION FACTORS

The decontamination factor (df) for Cs is being investigated to determine precisely the df for each piece of process equipment. In particular the df for HEPA filters when the influent offgas stream has trace radionuclide concentrations is under study. The dust loading and service life for the HEPAs are being determined as part of this program.

11.0 ABNORMAL OCCURRENCES AND ACCIDENT ANALYSES

The TN-220 Radwaste Incineration System is designed to limit uncontrolled releases of radioactivity during probable abnormal occurrences and postulated accidents. Abnormal occurrences include events which are expected infrequently over the life of the system such as individual component failures. Accidents are more serious events which are not expected to occur but which are not completely impossible. The radiological consequences of abnormal occurrences are negligible and even for postulated accidents the consequences are minimal.

11.1 ABNORMAL OCCURRENCES

Abnormal occurrences during operation result from failure of individual components. These failures will result in degraded system performance or cause the system to be shutdown. The alarms and interlocks associated with the instrumentation provided with a TN-220 assure safe operating limits will not be exceeded during abnormal occurrences. The abnormal occurrences which could be expected are described in the following paragraphs.

Gasket failures: The TN-220 is refractory lined from the furnace to the exit of the secondary filter. Replacement of the refractory may be required during the operating life of the system and for this reason flanged and bolted construction is used in the furnace and in the piping connecting the furnace and high temperature filters. If the gaskets used in these flanged connections fail, the result would be leaks into the system. Such leaks do not significantly degrade the operation of the system and have no radiological consequences. Leakage is into the system because a negative pressure relative to the building is maintained upstream of the induced draft fans. Downstream of the fans there is a slight positive pressure in the piping delivering the offgas to the stack but this piping is of all welded construction.

Filter candle failures: A high temperature resistant ceramic filter candle fails when a length of candle including the closed end breaks off and falls to the bottom of the filter housing leaving an unfiltered flow path through the hollow center of the remaining piece.

Breakage of a candle is an instantaneous occurrence monitored by a system of microphones which record the noise made by the piece of candle hitting the bottom of the filter housing. The record of the candle breaking informs the operators of the status of the candles in each filter housing and allows them to take appropriate action for continuing system operation. Failure of a candle by breakage permits a small fraction of the offgas flow to pass unfiltered. Breakage of a filter candle in a primary filter housing slightly degrades the filtration of the system but is not significant because the offgas is refiltered in the secondary filter. Similarly, breakage of a filter candle in the secondary filte [illegible] lts in slightly degraded system performance but again [illegible] not significant because the offgas must pass through HEPA filters. No radiological consequences result from filter breakage due to the small percentage of offgas passing through a housing unfiltered and the additional filtration downstream of the broken candle. Detectable increases in radioactive release rates may occur but even with such small increases the release rates will be far below permissible levels.

Fan failure: An induced draft fan failure could be caused by several factors. When one of the two induced fans fails during operation, the backup fan starts and the waste feed is stopped. The backup fan is then used to maintain a negative pressure in the system while the broken fan is repaired. No radiological consequences are expected.

11.2 ACCIDENTS

Accidents during operation are not expected to occur but have been considered and provisions have been made to alleviate the potential consequences. Table 11-1 lists the accidents which were considered, the provisions designed into the TN-220 to alleviate the potential consequences and the estimated radiological consequences. Table 11-1 shows that none of the accidents result in an unacceptable consequence for the operators or offsite.

The accident with the greatest potential consequence is gross failure of the ash storage bin. The ashes contain practically the entire inventory of the radionuclides of the incinerated waste. Therefore, special precautions have been taken to assure no serious radiological consequences occur. Specifically the storage capacity of the bin is limited to the ashes from three days operation which limits the radioactivity content of the ash to less than three curies. The ash storage bin is located in a locked cubicle as no access is required during normal operation. Failure of the bin will result in contamination only of the cubicle and a small occupational exposure during cleanup. Airborne activity is also likely to result because the ashes are still unsolidified in the ash storage bin and cleanup of a spill will stir up some contamination. However, the building housing the TN-220 is at a slight negative pressure and the air filtration system for the building will remove the airborne contaminants. No offsite releases are expected.

Table 11-1

ACCIDENT ANALYSIS

Potential Accident	Provisions to alleviate potential consequences	Estimated radiological consequences
Fire in the waste feed system	Both fire and smoke detectors are installed in the waste feed system which actuate a Halon fire extinguishing system in case of a fire.	No radiological consequences are expected because the fire is automatically extinguished and the feed system is isolated when the fire extinguisher is actuated.
Simultaneous failure of both induced draft fans.	Failure of the backup fan when one fan has already failed would result in no negative pressure being maintained in the system.	No radiological consequences are expected because the failure of the first fan would have stopped the waste feed and the generation of offgas. The residual heat in the system could still be removed by natural convection.
Failure of ash storage bin	The ash storage bin is in a cubicle.	Minimal radiological consequences are expected because the ashes would be confined to a small area. Local decontamination would be required and some airborne contamination could result.

12.0 REFERENCES

1 ERDA-76-43, Vol. I, Alternatives for Managing Wastes from Reactors and Post-Fission Operations in the LWR-Fuel cycle, U.S. Energy Research and Development Administration, 1976.

2 WASH-1258, Vol. I, Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low as Practicable" for Radioactive Material in Light Water Cooled Nuclear Power Reactor Effluents, U.S. Atomic Energy Commission, 1973.

3 ANSI/ANS-55.1 (1979) American National Standard for Solid Radioactive Waste Processing System for Light Water Cooled Reactor Plants, American Nuclear Society, 1979.

4 NUREG 0521, Radioactive Materials Released from Nuclear Power Plants (1977), U.S. Nuclear Regulatory Commission, 1979.

5 Krause, H., et al, "Treatment of Low-Level Solid Waste at the Karlsruhe Nuclear Research Centre," paper given at the Symposium on Practices in the Treatment of Low-and Intermediate-Level Radioactive Wastes, Vienna, Austria, December 1965.

6 Baehr, W., et al, "Experiences in the Treatment of Low-and Intermediate-Level Radioactive Wastes in the Nuclear Research Center, Karlsruhe," paper given at the Symposium on Developments in the Management of Low-and Intermediate-Level Radioactive Wastes, Aix-En-Provence, France, September 1970.

7 Baehr, W., et al, "Incineration Plant for Radioactive Waste at the Nuclear Research Center Karlsruhe," paper given at the Joint Power Generation Conference, Buffalo, NY, September 1976.

8 Hempelmann, W., "The Incineration of Low Level Radioactive Waste," paper given at the ASME Radwaste Management Course, Zurich, Switzerland, October 1978.

9 U.S. Patent for a Method and Device for Incinerating Radioactive Wastes and Preparing Burnable Wastes for Non-Polluting Storage by W. Hempeleman, Patent number 3,922,974, December 1975.

APPENDIX A

QUALITY ASSURANCE PROGRAM

FOR THE

TN-220 RADIOACTIVE WASTE

MANAGEMENT SYSTEM

Pages 50 through 85 of this topical report have not been renumbered from the original document E-2348. These pages are considered pages 50 through 85 in this report and Appendix B begins on page 86.

E-2348

Revision 0

[redacted]

Uncontrolled Copy

QUALITY ASSURANCE PROGRAM

FOR

DESIGN AND MANUFACTURE

OF

RADIOACTIVE WASTE MANAGEMENT

SYSTEMS AND COMPONENTS

TRANSNUCLEAR, INC.
ONE NORTH BROADWAY
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REVISION LOG

Rev. No.	Date	Approved	Description
0	10/13/80	[signature]	Original Issue

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INTRODUCTION

As the prime contractor, TN has Quality Assurance responsibility for all phases of design, manufacture, and inspection of systems and components which are supplied by TN. This QA responsibility exists whether TN has contractual responsibility for each of the individual phases of the project or not. The present document describes TN's QA Program for the design, fabrication, inspection and testing of radioactive waste management system components and subassemblies to be used at facilities licensed under 10CFR50. The organization of this document follows that of Appendix B 10 CFR 50, in that sections are numbered and titled the same as the corresponding 18 criteria of Appendix B.

1. ORGANIZATION

The organizational structure which has been set up at TN to establish and implement its QA Program is shown in Fig. 1. The authority and duties of the personnel performing activities affecting the safety related functions of TN supplied equipment and systems are described below.

The Chief Engineer is the person responsible for establishing the QA Program. He reports directly to the President of TN. The President shall approve the QA Program and any revisions thereto. The Chief Engineer shall approve Corporate QA Procedures and any revisions thereto. The minimum qualification requirements for the position of Chief Engineer are a bachelor's degree in engineering from an accredited institution and ten years of experience in engineering and quality assurance activities.

For each project one person from the TN organization shall be assigned as the QA Engineer for that project. The person who is assigned as the QA Engineer for a particular project shall have no other responsibilities on that project. He shall be functionally independent of any group or individual directly responsible for the activities which he monitors. He shall have the authority and organizational freedom to enforce QA requirements, to identify problem areas, to recommend or provide solutions to QA problems, and to verify the effectiveness of the solutions. As shown by the solid line in Fig. 1, he can communicate directly with the President. The minimum qualification requirements for the position of Project QA Engineer are a bachelor's degree in engineering, physical sciences, mathematics or quality assurance from an accredited institution and five years of experience in engineering activities with at least one year of experience in quality assurance activities.

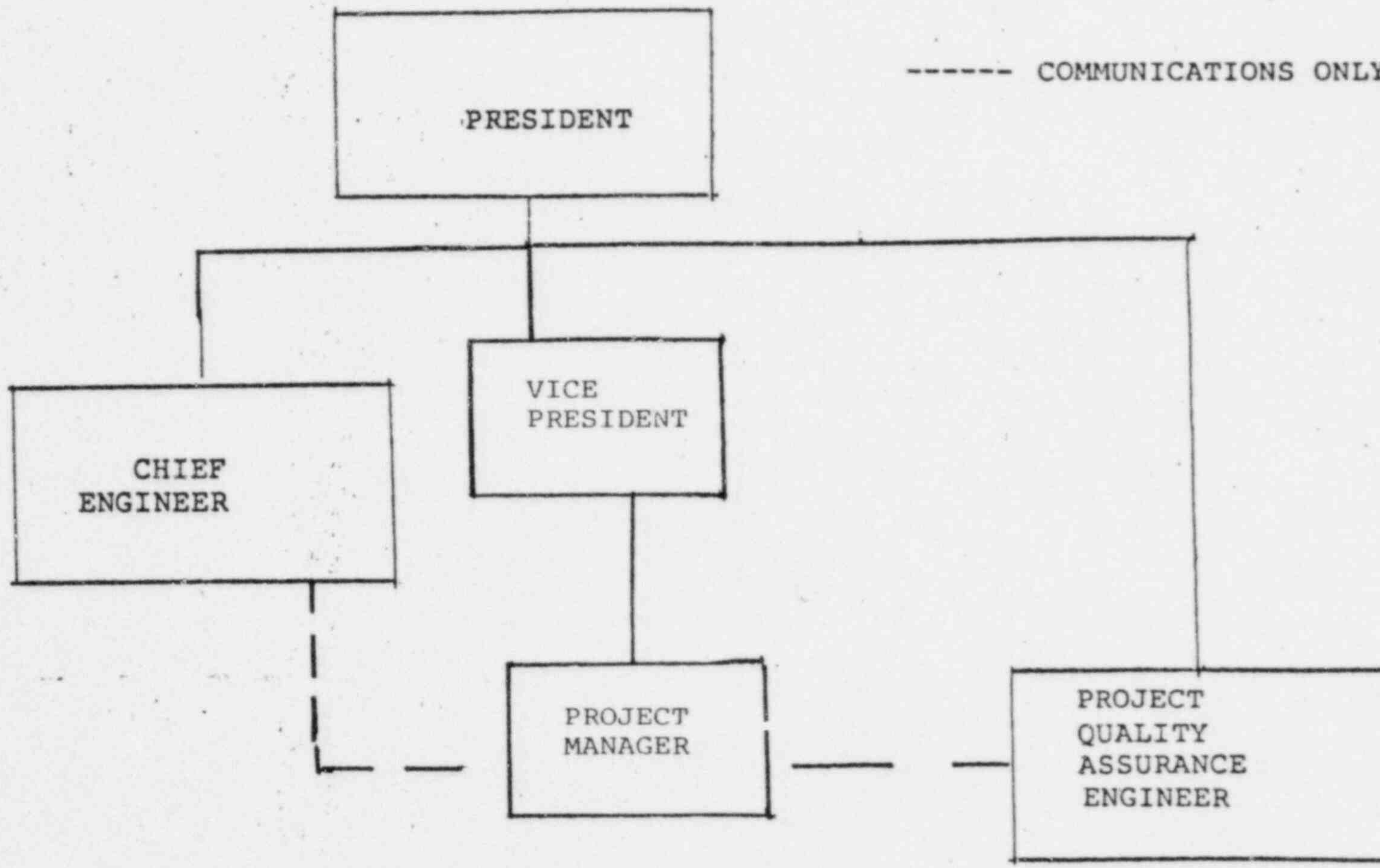

FIG.1 TN ORGANIZATION CHART

The QA Engineer has the following typical responsibilities:

a. Prepare TN's QA Program Plans and QA Procedures for specific projects.

b. Verify that major participating organizations have approved QA Programs, as required.

c. Approve QA Program Plans of participating organizations for a project for which he has been assigned as the QA Engineer.

d. Verify that major participating organizations have QA procedures, as required.

e. Assure that TN design documents contain applicable QA requirements.

f. Approve TN safety related procurement documents instructions, procedures and drawings.

g. Assure that further processing, delivery, installation or use of non-conforming items is controlled until proper disposition has occurred.

h. Perform audits to verify that QA requirements are being met.

The QA Engineer may delegate the performance of one or more of these functions to other qualified individuals at TN, or from contractor organizations, who do not have direct responsibility for performing the work being monitored.

A Project Manager or Project Engineer shall be responsible to the Vice President for the technical aspects of a project including issuing of procurement documents, preparation of licensing documents, fabrication and delivery of the equipment.

A possible interrelationship between TN and other major participating organization is shown in Fig. 2. The other organization could be a sub-contractor or supplier. The chart is provided to establish that any organization performing functions affecting quality must have a QA position with the required authority and organizational freedom as well as direct access to upper levels of management. The chart also shows the requirement for direct communication between Quality Assurance of TN and the other organization. As prime contractor, TN shall retain overall responsibility for the QA program.

Specific organization charts of major participating organizations shall be detailed in their respective QA documents, and shall be in full compliance with the applicable QA requirements of 10 CFR 50, Appendix B.

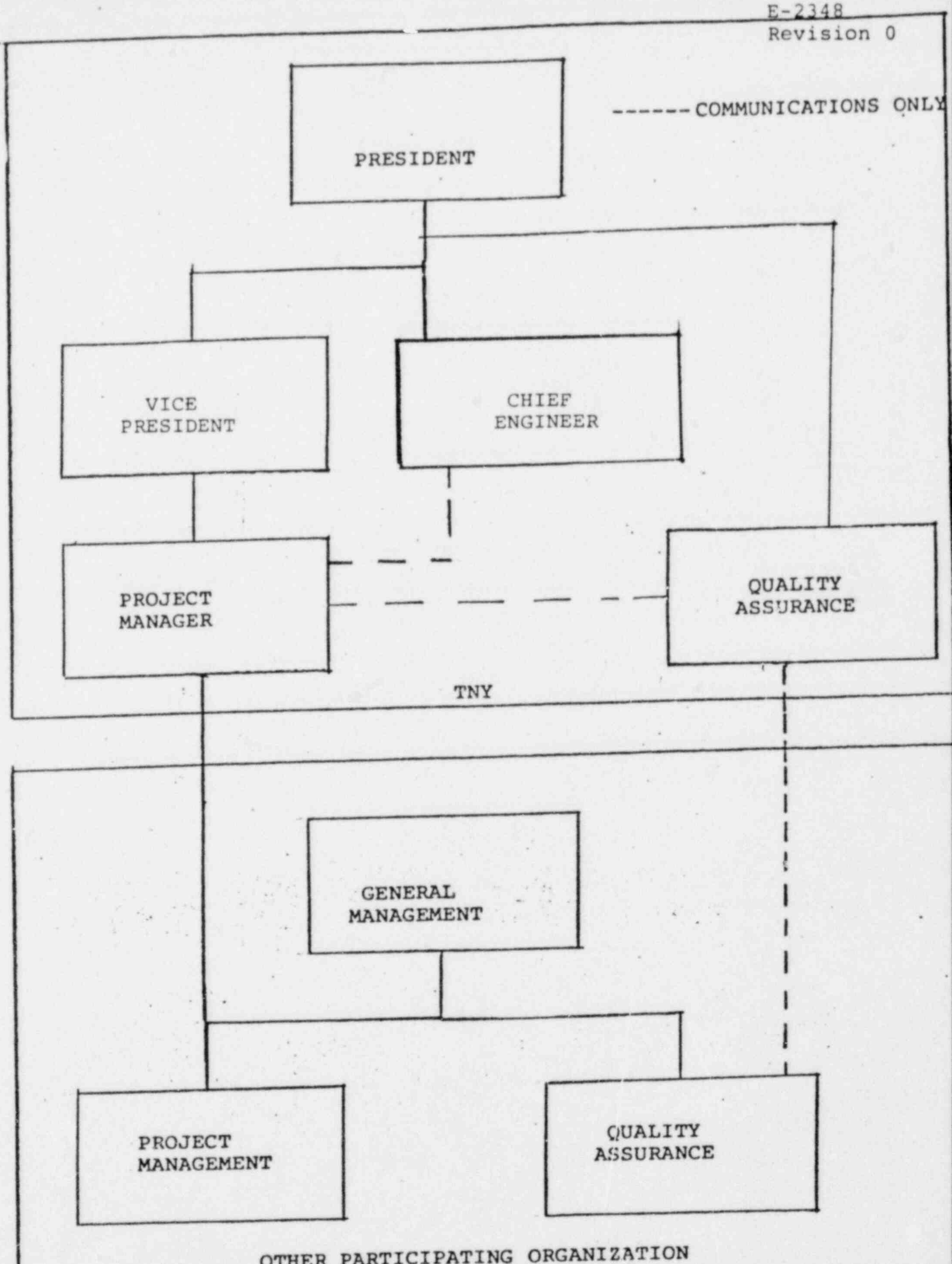

FIG. 2 TYPICAL OVERALL ORGANIZATIONAL CHART

2. QUALITY ASSURANCE PROGRAM

The program described herein is a generic program which shall be implemented by TN as a supplier of radioactive waste management systems and components. The program is intended to be in full compliance with the applicable requirements of 10 CFR 50, Appendix B.

It is the policy of Transnuclear, Inc. to establish and maintain an integrated quality assurance system which governs the design, fabrication, inspection and testing of systems and components to be utilized at nuclear facilities for the processing of radioactive materials. This system applies to all safety related activities performed by TN, or its' contractors, to assure that the equipment and systems meet the high standards of reliability and safety required for radioactive material handling and processing. The quality assurance system utilizes Project QA Program Plans, Corporate QA Procedures and Project QA Procedures to define specific quality assurance requirements for implementation of the generic QA Program at TN. Comparable plans and procedures shall be utilized by TN contractors.

Specific QA Program Plans shall be prepared to detail the actual measures which are to be established and implemented for a particular project. Each specific project QA Program Plan shall identify the participating organizations, their inter-relationships and the responsibilities of each of the participants. The scope of specific QA Program Plans will differ based upon the type and complexity of the quality affecting activities to be performed.

QA Program Plans for projects shall be established at the earliest time consistent with the schedule for accomplishing activities on such projects. Specific measures shall be established in the QA Program Plans directly or by reference to Corporate QA Procedures, which are applicable to all TN projects, or to Project QA Procedures which are only applicable to specific projects. The Corporate QA Procedures are used for activities such as Drawing Control, Procedure Format, Document Transmittals, etc. Project QA Procedures are used for specific project activities unique to a particular project. The TN Project QA Engineer shall identify all QA procedures required during a particular phase of a project during the development of the QA Program Plan. If QA procedures so identified do not yet exist, they shall be prepared as either Corporate or Project QA Procedures, approved, and issued prior to the performance of the activities covered by the procedures.

Preparation of the QA Program, and subsequent revisions thereto, are the responsibility of the Chief Engineer. The President of TN shall approve the original QA Program and any subsequent revisions. QA Program Plans for spe ific projects and any revisions thereto, shall be approved by the Project QA Engineer. Corporate QA Procedures are approved by the Chief Engineer. Project QA Procedures are approved by the Project QA Engineer.

The distribution of the QA Program is controlled by TN's Chief Engineer. He is also responsible for the distribution of Corporate QA Procedures. The Project QA Engineer is responsible for the distribution of Project QA Procedures. He assures that responsible organizations and individuals are aware of all mandatory QA requirements for project activities under their cognizance and that copies of the general and specific QA program, plans and procedures are distributed to them, as applicable.

Major organizations participating in a project shall have approved quality assurance programs including written procedures and instructions to implement their respective programs. Their programs, procedures and instructions shall be in full compliance with the applicable criteria of 10 CFR 50, Appendix B. These QA programs shall be formally reviewed and accepted for use by the TN Project QA Engineer prior to the initiation of activities affecting quality.

Specific project QA Program Plans prepared by major participating organizations shall be approved by the TN Project QA Engineer. He shall perform audits and/or overchecks to assure that these programs and procedures are properly implemented by the participating organizations.

The Project QA Engineer is responsible for verifying on a particular project that all activities on safety-related systems, components and equipment are controlled by the QA program. In case of disputes with the TN Project Manager or others over quality matters he can request resolution by TN's President.

Safety related items shall be identified for each specific design. The complexity and importance of these items shall be defined and any special requirements shall be described.

TN shall hold annual QA Review Meetings to assess the adequacy and effectiveness of the QA Program. These review meetings shall be chaired by the President. The Chief Engineer and QA Engineers for ongoing projects shall attend. These reviews shall be documented and shall include a list of follow-up action items, designating responsibilities and schedules for implementation.

TN and major participating organizations shall provide suitable conditions, environment and equipment for activities affecting quality. Special controls, tools, equipment, etc. shall be provided to attain the appropriate level of quality. Inspections, tests and other controls shall be implemented to assure that the appropriate levels of quality are attained.

Personnel performing activities affecting quality shall be properly trained and indoctrinated as to the purpose, scope and proper implementation of the QA Program, the specific QA Program Plan, and QA Procedures to assure proficiency for the tasks which they are to perform. The proficiency of TN personnel performing activities affecting quality shall be maintained through a program of on-the-job training and indoctrination meetings as required.

3. DESIGN CONTROL

TN shall establish measures to assure that appropriate regulatory and quality requirements have been or are correctly translated into drawings, specifications, procedures and instructions. The design shall consider, but shall not be limited to the following design aspects: shielding, stresses, thermal and hydraulic performance, accident conditions, compatibility of materials, accessibility for in-service inspection, maintenance and repair.

Measures shall be established for the selection of suitable materials, parts, equipment, and processes for safety-related structures, systems and components. Valid industry standards and specifications shall be utilized to the greatest practical extent.

Design calculations and drawings shall be prepared and checked in accord with approved procedures. Materials, parts and equipment which are standard, commercial (off the shelf) or which have been previously approved for a different application shall be reviewed for suitability prior to selection.

In addition, the design shall be formally reviewed by individuals or groups, other than those who performed the original design. These reviews shall be in the form of Design Review Meetings for designs which are developed by TN. For such designs, the Project Manager shall schedule and chair review meetings. These meetings shall be held to confirm that various aspects of the design have been properly considered. The Project Manager and Project QA Engineer shall review design documents to assure that the design characteristics of the equipment or system can be controlled, inspected, and tested and that appropriate inspection and test criteria have been identified. The Design Review Meetings shall also assure that there has been, is and will be appropriate coordination between organizations participating in the design, quality control, fabrication, and testing of the equipment or system.

Any errors or deficiencies in the design or design documents, including the design process, that could adversely affect safety-related components or sub-components of a waste management system shall be documented, and corrective action shall be taken in accordance with Section 16 of this Program.

TN shall assure that measures are established and implemented to verify that the fabrication and assembly drawings, prepared by the Manufacturers are consistent with design documents. For equipment and systems of TN design, TN shall review all fabrication drawings, approve design changes and establish procedures for the documentary control of design changes.

All design changes, including field changes, shall be subject to the same or equivalent design control measures as are applicable to the original design.

TN shall establish measures to assure that the approved design and operating conditions are not changed unless the effect of the changes on the design are evaluated and approved.

4. PROCUREMENT DOCUMENT CONTROL

Procurement documents shall be prepared which clearly define all design requirements including quality assurance requirements, and shall reference all applicable documents, including codes, standards and regulatory requirements. These documents shall serve as the principal technical documents for the procurement of materials, spare parts, components, equipment or services to be used in the manufacture and inspection of safety related components or systems.

These documents may be prepared by TN or by one or more major participating organizations, e.g. Design Agent, Manufacturer, etc. Each of these organizations shall have a documented, approved quality assurance program which shall be supplemented by detailed procedures and instructions as required to assure adequate control for preparing safety related procurement documents. Changes and revisions to these documents shall be reviewed and approved in an equivalent manner as the original document in accordance with documented procedures. These programs shall also include measures to qualify/accept the quality assurance programs of their suppliers and subcontractors for safety related equipment, materials or services.

Procurement documents shall also address the applicability of the provisions of 10 CFR 21, Reporting of Defects and Noncompliance.

Safety related procurement documents prepared and/or issued by TN shall be reviewed by the Project QA Engineer to determine that appropriate quality requirements are correctly stated, inspectable and controllable. The QA Engineer shall also verify that adequate acceptance and rejection criteria are identified and that the procurement document was prepared, reviewed and approved in accordance with the applicable procedures. The QA Engineer's written approval of the procurement documents shall signify that he has verified these items prior to the release of the documents.

TN's safety related procurement documents shall identify which documents (e.g. drawings, specifications, procedures, inspection and fabrication plans, inspection and test records, personnel and procedure qualifications, and chemical and physical test results of materials) are to be prepared by a supplier and which documents are to be submitted to TN or its agents for review, information and/or approval. The procurement documents shall also specify which documents are to be retained, controlled and maintained by the supplier for specified periods and which records shall be transmitted to TN prior to installation of the equipment. Duplicate records may be maintained for specified periods by both the supplier and TN to facilitate permanent record storage.

Procurement documents shall also include requirements to insure that TN, its clients or its agents have reasonable rights of access to the supplier's facility and records for source inspection and audit prior to contract award, and inspection and audits during and after completion of fabrication.

5. INSTRUCTIONS, PROCEDURES AND DRAWINGS

Methods for complying with each of the applicable 18 criteria of 10CFR50, Appendix B for activities affecting quality during design, manufacture, test and inspection shall be specified in instructions, procedures and/or drawings. They shall be prepared, reviewed, approved and controlled in accord with written document control procedures.

These instructions, procedures and drawings shall include quantitative and/or qualitative acceptance criteria to permit verification that activities affecting quality have been satisfactorily accomplished.

The QA Engineer on a project shall review and approve Project instructions, procedures and drawings which are prepared by TN. These documents may include, but are not limited to specifications, drawings and inspection instructions and procedures and any changes thereto.

6. DOCUMENT CONTROL

TN shall establish and implement procedures to control the issuance of TN documents which prescribe activities affecting quality. These procedures shall define document control measures to assure adequate review, approval, release and distribution of original documents and subsequent revisions. These documents may include, but are not limited to design specifications, drawings, procurement documents, and special process, test and operating procedures. A specific QA Plan for each project shall identify the persons, groups and/or organizations responsible for reviewing and approving documents and their revisions for that project.

Major participating organizations shall establish and implement control procedures in accord with their approved QA Program.

Changes to documents shall be reviewed and approved by the same organizations that performed the original review and approval unless otherwise delegated by TN or a major participating organization. Approved changes shall be included in the applicable drawings, procedures, instructions or other documents prior to the implementation of the change.

The Project Manager shall be responsible for the control of Project documents which are issued by TN. He shall also be responsible for the receipt and distribution of Project documents to and from participating organizations. He shall maintain an up-to-date file of all Project records.

Documents shall be available at the location where activities affecting quality are performed prior to commencing the work.

For certain types of documents which are issued by TN, the Project Manager shall maintain Master Lists to identify current revisions. He shall update and distribute these lists to responsible personnel to preclude the use of superseded documents. Major participating organizations shall utilize the same or equivalent measures.

7. CONTROL OF PURCHASED MATERIAL, EQUIPMENT AND SERVICES

Measures shall be established and implemented to assure that all safety related purchased material, equipment, and services conform to procurement documents.

An engineering source evaluation of prospective supplier's facilities shall be performed by the TN Project Manager to confirm that the organization has the technical capability to supply safety related equipment, materials or services in accordance with the project's design, manufacturing, quality assurance and procurement requirements.

The TN Project QA Engineer shall perform source evaluation audits of potential suppliers in accordance with TN Corporate QA Procedures to verify that they can comply with the applicable criteria of 10 CFR 50, Appendix B that are applicable to the material, equipment, or service being procured.

The resultant reports of the engineering source evaluations and source evaluation audits shall be filed and retained in accordance with Section 17 of the applicable QA procedures.

The Project QA Engineer shall inspect and audit contractors and sub-contractors at suitable intervals to verify that they comply with quality requirements and to assess the effectiveness of their QA program.

Suppliers shall provide objective evidence that systems and associated components, including repaired or spare parts, meet all quality requirements. All items shall be properly identified. Appropriate records shall be available prior to use of installation to permit verification of conformance with procurement documents. These records shall be retained accessibly (See Section 17). The supplier shall furnish to TN all documentation which identifies all procurement requirements which have not been met together with nonconformance reports dispositioned "accept as it" or "repair". These documents shall be reviewed by the Project Manager and TN's design agent (if applicable) to assure conformance with the license application. The Project QA Engineer shall accept these documents in writing. Project procedures shall specify client requirements for the identification, control and approval of nonconformances.

Supplier's certificates of conformance for safety related material and components furnished to TN shall be periodically evaluated by audits, independent inspections or tests to assure that they are valid. The frequency and extent of these evaluations shall be related to the safety importance of the procured material or equipment.

TN or its agents shall perform inspections on safety related components and equipment to be furnished to assure that the component or equipment is properly identified and corresponds to the procurement documentation. The inspections shall verify that the component or equipment conforms to the requirements of previously established criteria. These inspections shall be performed utilizing previously established inspection instructions. Safety related component and equipment suppliers shall have QA programs which contain measures equivalent to the above, and in addition assure that accepted material, components and equipment are identified as to their inspection status prior to forwarding them to a controlled storage area or releasing them for further work or installation. Nonconforming materials, parts or components shall be controlled in accordance with Section 15.

8. IDENTIFICATION AND CONTROL OF MATERIALS, PARTS AND COMPONENTS

Measures shall be established and implemented to identify and control safety related materials, parts, and components. These measures shall assure identification of an item by an appropriate means during the fabrication, installation and use of the item and shall prevent the inadvertent use of incorrect or defective items. The requirements for identification shall be established during the preparation of procurement specifications and design drawings. The methods and location of identification information shall be selected so as to not adversely affect the fit, function or quality of the items being identified.

The identification and control of safety-related items shall be traceable through procurement, fabrication, inspection and test records. Correct identification of components, materials and components shall be verified and documented prior to release of the equipment, materials or components for fabrication, assembly shipping and installation.

9. CONTROL OF SPECIAL PROCESSES

Measures shall be established and implemented for the control of special processes used in the manufacture and repair of safety related radioactive waste management systems and components. These processes include welding, non-destructive testing and other processes special to a specific system or component.

Safety related special processes shall be performed in accordance with approved written procedures. Personnel who perform such processes shall be formally trained and qualified in accordance with applicable codes, standards or specifications. Qualification records of procedures and personnel shall be filed and kept current by the organization which performs the special process.

10. INSPECTION

Measures shall be established and implemented to inspect materials, parts, processes or other activities affecting quality to verify conformance with documented instructions, procedures, specifications, drawings, or other procurement documents. These inspections shall be performed by personnel other than those who performed the activity being inspected. Inspectors shall be qualified in accordance with the applicable codes, standards, and the training programs of TN or its contractors. Inspector qualifications and certifications shall be maintained current and these records shall be retained in accordance with Section 17 of this Program.

Inspections shall be performed in accord with approved, written instructions and procedures. The instructions and procedures shall include and address acceptance criteria; identify the characteristics and activities to be inspected; identify the individuals or groups responsible for performance of the inspection operations; describe the method of inspection; record evidence of completion and verifying of a manufacturing, inspection or test operation; and record the identity of the recording inspector or data recorder and the results of the inspection operation. When direct inspection is not possible, provisions shall be established for indirect control by monitoring processing methods, equipment, and personnel.

Mandatory hold points shall be established for inspections or witnessing, as required. Work shall not proceed beyond a hold point without the consent of the designated inspector.

Modifications and/or repairs to and replacements of safety related components or equipment shall be inspected in accordance with the original design and inspection requirements or acceptable alternatives.

11. TEST CONTROL

A program shall be established and implemented to perform required proof tests, as identified in procurement documents.

The tests shall be performed by qualified personnel in accordance with approved, written instructions, procedures and/or checklists. Test procedures shall incorporate or reference the applicable requirements and acceptance limits contained in the design and procurement documents; instructions for performance of the test; test prerequisites such as test equipment requirements, personnel qualification requirements, fabrication or operational status of the item to be tested and the provisions for data recording and retention; and mandatory inspection hold points to allow witnessing by TN or it's agents.

Test results shall be documented and evaluated. They shall demonstrate that acceptance criteria have been met.

12. CONTROL OF MEASURING AND TEST EQUIPMENT

Measures shall be established and implemented to assure that tools, gages, instruments and other measuring and testing devices used in activities affecting quality are properly controlled, calibrated and adjusted to maintain accuracy within necessary limits. These measuring devices shall be calibrated at scheduled intervals against certified standards having known, valid relationships to national standards. All calibrations shall be performed in accordance with approved written procedures.

Measuring and test equipment shall be identified and traceable to the calibration records, and shall be labeled or tagged indicating the next required calibration date.

When measuring and test equipment is found to be out of calibration, measures shall be taken and documented to determine the validity of inspections performed during the period the equipment was out of calibration. The complete status of all measuring and test equipment under the calibration system shall be recorded and maintained.

Test equipment shall be subjected to a proof test to demonstrate that it performs its intended function prior to its use for testing safety related components.

13. HANDLING, STORAGE AND SHIPPING

Measures shall be established and implemented to assure that all safety related materials, components, assemblies, spare parts, special tools and equipment are handled, stored, packaged and shipped in a manner which prevents damage, loss of identity or deterioration. These activities shall be carried out in accordance with written approved procedures.

When necessary, storage procedures shall address special requirements for environmental protection such as inert gas atmospheres, moisture, temperature levels, etc. Specific client requirements for shipping and storage shall be included in the project procedures.

14. INSPECTION, TEST AND OPERATING STATUS

Measures shall be established and implemented to assure that the status of required inspections and tests of safety related materials, components and systems are clearly indicated by some suitable means, e.g. tags, labels, cards, form sheets, check lists, etc. The status of nonconforming items is of particular concern (see Section 15).

By passing of required inspections, tests or other critical operations shall be controlled in accordance with written procedures or instructions by the TN QA Engineer and/or TN's inspection agent.

The application and removal of status indicators shall be in accord with approved written instructions and procedures.

15. NONCONFORMING MATERIALS, PARTS OR COMPONENTS

Measures shall be established and implemented to control safety related materials, parts, and components which do not conform to requirements so as to prevent their inadvertent use in subsequent manufacturing operations or during service.

These measures shall be described in approved written instructions and procedures. Specific client requirements for the identification, control and disposition of nonconformances shall be included in the procedures and instructions. The nonconforming items shall include items which do not meet specification or drawing requirements, as well as items which are not fabricated, inspected or tested in accordance with approved written procedures or by qualified processes or by qualified personnel, where the use of such procedures, processes or personnel is required by the fabrication, test, inspection or quality control documents.

Nonconforming items shall be identified and segregated to prevent their inadvertent use. Nonconformance reports shall be utilized for the procedural control of nonconformances. They shall describe the nonconformances and provide for their disposition. Inspection requirements for nonconforming items following rework, repair or modification shall be detailed in the nonconformance reports which shall be approved and signed following completion of the disposition. The acceptability of the rework or repair of nonconforming materials, parts, and components shall be verified by reinspecting and/or retesting the reworked or repaired item to the original requirements, or by a method which is at least equal to the original inspection and/or testing method. Inspection, testing, rework, and repair procedures shall be documented and controlled.

Nonconformance reports shall be utilized to notify other affected organizations. Items which are not in conformance with TN approved documents shall be reviewed by TN's Project Manager and QA Engineer. Their disposition shall be approved by TN's QA Engineer. Nonconformances with documents such as fabrication details, which may not require TN approval, may be resolved without TN approval by major participating organizations, as appropriate, in accord with their approved QA programs.

Nonconformance reports shall be made part of the inspection records. They shall also be reviewed periodically to identify quality trends. The results of these reviews shall be reported to management for their assessment.

Procedures shall be established and implemented to report defects and noncompliances in accord with the provisions of 10 CFR 21.

16. CORRECTIVE ACTION

Measures shall be established and implemented to assure that conditions adverse to quality are promptly identified and corrected to preclude repetition.

Personnel responsible for quality assurance shall periodically review nonconformance reports and operating reports relating to failures, malfunctions and deficiencies to assess the need for corrective actions. They shall advise their respective managements of such needs, document decisions and appropriate courses of action, and perform the necessary follow up to verify that the corrective actions have been taken.

17. QUALITY ASSURANCE RECORDS

For each safety related component or equipment, a program shall be established and implemented to assure that sufficient written records are maintained to furnish evidence of activities affecting quality. These records include, but are not limited to, design and procurement records, and the results of reviews, inspections, tests, audits, monitoring of work performance, materials analyses, and related procedures such as qualifications of personnel and equipment. The record program shall be based on ANSI N45.2.9 "Requirements for Collection, Storage, and Maintenance of Quality Assurance Records for Nuclear Power Plants".

Quality assurance records shall be collected by the originating organization as the documents are completed. They shall be stored by these organization(s) until delivery of the component or equipment. The requirements and responsibilities for record transmittals, record retention, and maintenance by the originating organization(s) prior to completion of the work shall be in accordance with the applicable codes, standards, procurement documents, and the organizations' QA program. Approved, written procedures shall be utilized to control and maintain QA records.

Inspection and test records shall contain, where applicable, the description of the type of observation; evidence of the completion and verification of a manufacturing, inspection, or test operation; the date and results of the inspection or test; any information related to conditions adverse to quality; the identification of the inspector, data recorder or test operator; and evidence of the acceptability of the test or inspection results.

The record program shall identify which types of records are to be transmitted to TN for retention by TN or its client and which ones shall be retained by the originating organization in accord with procurement document requirements, Section 4. "Lifetime" records shall be retained by TN or its client. The records shall be identified, indexed and stored in accessible locations. The record storage facility shall be constructed, located and secured in accordance with written procedures to prevent destruction of the records by fire, flooding, theft, and deterioration by environmental conditions such as temperature and humidity. Alternatively, duplicate storage of records at two separate and segregated locations may be utilized to prevent loss or destruction.

Maintenance of records at TN shall be in accord with written approved procedures. These procedures shall address duration of storage, responsibilities for safekeeping, preservation, and disposition of nonpermanent records. Maintenance of records at participating organizations shall be in accord with their approved program.

18. AUDITS

A comprehensive program of planned and periodic audits shall be established and implemented by TN to verify compliance with all aspects of the TN QA Program and to determine its effectiveness. The audit program shall include audits by TN of it's suppliers' QA programs, procedures and activities to verify and evaluate that the suppliers' procedures and activities are meaningful and comply with the overall QA Program. Suppliers of safety related equipment, material or services to TN shall implement a program to verify compliance with all aspects of their QA program and to determine its effectiveness.

The audit program shall describe the areas to be audited, such as design, fabrication, inspection or testing activities. The schedule for such audits shall be based upon the safety importance of the activities being audited.

The audits shall be performed by qualified personnel not having direct responsibilities in the areas being audited. The audits shall be conducted in accord with written approved procedures and/or check lists. Audit results shall be documented, and shall be reviewed with personnel having responsibility for the area audited. Agreements on corrective actions and schedules for implementation shall be established and recorded. Reaudits of deficient areas shall be scheduled on a timely basis to verify implementation of agreed upon corrective actions. Audit reports shall include an objective evaluation by the auditor of the quality related practices, procedures and instructions for the area or activity being audited and the effectiveness of their implementation.

Audit reports shall be distributed to management. The reports shall be reviewed for indications of adverse trends which could affect quality. If the results of such assessments so indicate, pertinent sections of the QA program shall be revised.

Audits of project activities for which TN has direct responsibility shall be performed by the Project QA Engineer, except for audits of activities under his cognizance. The latter shall be performed by qualified personnel, nominated by TN's President, who have no responsibility for the activities being audited.

APPENDIX B TN-220 P&ID AND FUNCTIONAL DESCRIPTION

Dwg. SK-1004-00-01 Rev. 2 and pages 86 through 100 have been deleted from Topical Report TN-RW-101/00-NP in accordance with 10 CFR 2.790(b).