Root Cause Investigation Report

Title: The station's failure to recognize and respond to unacceptable conditions with respect to temporary tritium storage in a timely fashion resulting in release of tritiated water outside the intended control area.

Unit(s): Unit Common

Event Date: March 13, 2006

Event Time: 1145

Action Tracking Item Number: 465719

Report Date: March 22, 2006

Sponsoring Manager: Gary Dudek – Operations Director

There is one issue that remains open page 30, CA 2 is being evaluated for a CAPR by Engineering

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Executive Summary:

On March 13, 2006, the transfer hose for the temporary storage (FRAC) tank area (FRAC Tank Farm #1) located north of the Make-up Demineralizer System (MUDS) was discovered on the berm for the FRAC tanks. High winds coupled with the weight of the transfer hose, caused the berm wall to push inward and allowed water inside the berm to exit the controlled area (berm). The berm design, construction and installation did not account for degrading the integral "A" frame design of the berm wall, which prevented the berm wall from withstanding the high winds on the day of the event, in conjunction with the transfer hose falling on the berm wall.

Leakage from the FRAC tank fittings, level indication, and transfer equipment since FRAC tank operation began in early January 2006, resulted in tritiated water being present in the berm area. Due to inadequate standards and processes for tritiated water control at the station, the presence of the water was not acted upon aggressively and was allowed to remain in the berm.

Water samples were pulled from the two areas of surface water identified as possible over flow areas from the berm failing. An estimate of water that leaked from the berm was performed and the result was 280 gallons. Based on flow capacity of the pumps it

is estimated that 240 gallons of water was pumped back into the berm. The initial water sample results were 183,000 pCi/L. Sample results from the off-site laboratory determined that the highest level of tritium in the soil samples was 122,543 pCi/L (See Attachment 6 for FRAC Tank Farm #1 soil and water sample results).

The first root cause of this event was the berm was designed, constructed and installed such that the high winds in conjunction with the weight of the transfer hoses caused the berm wall to fall inward and thereby allowed water to exit the berm. Corrective actions to address this root cause were remediation of the berm wall installation; additional corrective actions have been created to install additional sample wells to monitor tritium migration. The second root cause for this event was that inaccurate risk perception resulted in a lack of standards with regard to tritiated water inside of the FRAC tank berm. Corrective actions to address this root cause ~~were~~ are development of a Training and Reference Material~~s~~ (T&RM) procedure for the cognizant work groups associated with the operation and maintenance of the FRAC tank installations. The third root cause of this event was that Standards, Policy or Administrative Controls (SPAC) were not established to ensure proper monitoring and control of water in the FRAC Tank Farm berm. Corrective actions for this root cause are the development of the T&RM as stated for the second root cause, with additional actions to present a case study of this event to station management.

Walkdown of the acid unloading station determined that the acid unloading berm is not secured to the ground. The berm in use at the FRAC Tank Farm #2 has also been identified as being deficient (IR# 466356 generated for this issue). For additional concerns, refer to the Extent of Condition section to follow. Nuclear Network Operational Experience (NNOE) and Nuclear Event Report (NER) assignments have been created to communicate this event to the industry.

The Nuclear Safety Risk Assessment showed no impact on station operation or response to postulated accident conditions. The event was not reportable under Reportability Manual, SAF 1.9, News Release or Notification of Other Government Agencies per 10 CFR 50.73.

Review of previous events discovered ~~three~~ two pertinent events: ~~1) high radioiodine concentrations discovered following the release of Waste Gas Decay Tanks (Reference IR# 261937), 2~~1) acid splash event (Reference IR# 292165) and ~~3~~2) Inadequate response to unplanned environmental tritium releases from Braidwood station (Reference IR# 428868). Although no specific corrective actions were created as a result of these ~~three~~ two events that would have prevented the event documented herein, there were aspects of each that are related. Details of these events and their relationship to this event are contained in the Extent of Condition section of this report.

Condition Statement:

On 03/13/2006, at approximately 1145, an Operations Field Supervisor reported to Radiation Protection that the south side of the berm wall that surrounds the FRAC tanks (FRAC Tank Farm #1) was down and resulted in water escaping from the FRAC tank area. Radiation Protection and Mechanical Maintenance Departments immediately responded to the area. The south wall of the berm was placed in the upright position and reinforced with sand bags on both the interior and exterior side of the berm wall.

Two locations outside of the berm were identified as possible areas where water had overflowed. These locations were sampled and the water was pumped back into the berm area. Samples from outside the berm taken while clean up was in progress showed tritium levels of 183,000 pico Curies per liter (pCi/L). Sample results from the off-site laboratory determined that the highest level of tritium in the soil samples was 122,543 pCi/L (See Attachment 6 for FRAC Tank Farm#1 soil and water sample results).

The consequences of this event were not ~~immediately~~ significant to the plant or the environment, as the water was captured shortly after identification of the leak. Soil samples were taken to characterize and remediate the extent of the spill. In addition sample wells will be installed to monitor any migration (CA 1). The significance of this event is the release of tritiated water onto the ground.

Event Description:

The following Event Description contains an Event Chronology (Page# 3~~3~~), FRAC Tank Design and Installation (Page# 8~~8~~), FRAC Tank Farm Operations (Page# 11~~10~~), Investigation Interviews (Page # 12~~11~~) and Identification of FRAC Tank Issue (Page# 18~~17~~) sections.

Event Chronology:

~~In November of 2005, due to historical Circulating Water Blow down line leakage of radioactive fluid, it was decided Braidwood Station would limit the release of radioactive fluids.~~Liquid radioactive effluent releases into the Braidwood Station circulating water blowdown line were suspended on November 23, 2005. This action was taken until additional information could be collected and testing conducted to ensure the integrity of the circulating water pipeline at all locations. ~~-~~This ~~required~~ suspension of releases required the creation of interim onsite storage while a long-term plan was being developed and implemented. For a description of the events leading up to this decision, reference root cause report # 428868.

On 12/19/2005, two temporary storage (FRAC) tanks were installed in accordance with EC# 358522 in the Unit 2 track way. The FRAC tanks were placed ~~on~~ in a ~~ready-made~~pre-fabricated berm. Use of the berm was considered a good practice since, by virtue of the FRAC tank location, any leakage occurring from the tanks would enter the Turbine Building drains that are monitored~~equipped with radiation detection~~. The two tanks installed in the Unit 2 track way (tanks 255499 and 255385) were filled during the timeframe of 12/22/2005 through 12/25/2005.

Additional temporary storage of tritiated water was required. 13 more FRAC tanks were installed onto a 60'x120' concrete pad to accommodate this need. This concrete pad formerly supported the M&O building, located 200' north of the Makeup Demineralizer System (MUDS) building. Use of a berm at FRAC Tank Farm #1 was considered necessary due to the outside installation. The installation of additional tanks began the week of 1/3/2006 in accordance with EC# 358725. Installation of 6 of the 13 tanks was completed on 1/9/2006, with Plant Operations Review Committee (PORC) review and approval of the installation completed the same day. Transfer of water to the first tank

(tank 254315) began the following day, 1/10/2006. Installation of the remaining 7 FRAC tanks continued over the next several weeks.

During water transfers on 1/10/2006, leaks were identified at threaded connections on ball valves located in the discharge hose. The leaks were minor (less than a cup full) and quickly addressed, this leakage occurred on the asphalt outside the berm area. All leakage was cleaned-up using absorbent materials. The leaks were initially hidden under the discharge hose insulation (Reference IR# 440735 for leakage and IR# 440770 for lessons learned from this first transfer evolution). A subsequent lesson learned IR (IR# 442760) was generated by Radiation Protection that documented 25 separate lessons learned and is currently in use for RP department pre-job briefs for FRAC work. The scope of the lessons learned was limited to RP work group actions necessary to perform work in the berms or on the FRAC tanks. It did not address tritium values (limits) or sampling frequencies.

On 1/18/2006, IR# 443611 was generated identifying a potential safety concern for the build-up of snow and ice in the berm area for FRAC Tank Farm #1. This IR remained at the Station Ownership Committee (SOC) through 1/26/2006 for resolution due to no clear owner of the FRAC Tank Farm #1 (See Other Issues section, CA 11 generated to address this concern). Since work continued in the FRAC Tank Farm #1 (installation of additional tanks), ~~it was~~the SOC assumed that Project Management was responsible for resolution of the snow/ice concern **(~~Causal Factor #4 – Contributing Cause #2~~Causal Factor #4 – Contributing Cause #1)**.

On 1/20/2006, a tritium analysis of the FRAC Tank Farm #1 berm area was taken and the results indicated 178,000 pCi/L. This condition was not documented in an IR or communicated to senior station management. Review of tritium analysis sample results from 1/1/2006 through 3/16/2006 concluded that the 1/20/2006 tritium sample was the first elevated tritium sample taken in the berm surrounding FRAC Tank Farm #1.

During the performance of a FRAC tank berm sample analysis on 1/21/2006, it was identified that the FRAC Tank Farm #1 berm tritium sample results were 174,000 pCi/L, which is above the on-site Lower Limit of Detection (LLD) value of 1670 pCi/L. The RP Duty Manager generated IR# 445016, communicated this through the duty team and brought the issue up at the 0800 Plan of the Day (POD) phone call on Sunday, 1/22/2006. A trouble-shooting plan was created to determine the source of the tritium input into the berm. The troubleshooter was performed and the exact input of tritium into the berm could not be determined. Suspected causes included the possibility of a leak from one of the FRAC tanks, piping or man-ways, the possibility of some spillage during routine sampling or FRAC tank level gauge draining. The berm water was pumped to a FRAC tank, although the exact date and time that the pumping occurred could not be determined (See Other Issues section, ~~RCIT~~ the Root Cause Investigation Team {RCIT} generated IR# 468008 for this concern).

IR# 445016 was closed to a Department Evaluation performed by Radiation Protection under IR# 443611. The cause determination of the evaluation in IR# 443611 was that poor documented guidance existed for working on or in the FRAC tank berm area. Two assignments were created: action #2 of this IR was to provide PowerPoint slides on expectations/rules for entry into the FRAC farm berm area (completed 2/3/2006) and

action #3 was to develop a Training and Reference Material (T&RM) to address berm/water issues, and was completed 3/8/2006. Interim guidance was never developed. An additional assignment was created to implement the T&RM, due 4/8/2006.It is an inappropriate action to develop guidance for working in the berm area two months after identification of the issue. RP closure of action item #3 only included the development of the T&RM for working in the berm area **(Causal Factor #3 – Contributing Cause #1Causal Factor #3 – Root Cause #3)**. An additional assignment was created to implement the T&RM, due 4/8/2006.

IR# 445016 generated for samples taken on 1/21/2006 was also the only IR generated that identified elevated tritium in FRAC Tank Farm #1 berm area, despite 20 multiple tritium analysis results greater than the on-site LLD value of 1,670 pCi/L (IR# 468626 generated by the RCIT to address this immediate concern) **(Causal Factor #6 – Contributing Cause #4Causal Factor #6 – Contributing Cause #3 – This causal factor is not explicitly identified for the remainder of this chronology, however, it is acknowledged that anytime a tritium sample result was greater than on-site LLD, an IR should have been generated. See Attachment 1 for the Event Casual Factor Chart and Attachment 8 7 FRAC Tank Farm #1 Berm Tritium Samples for the dates that IRs should have been generated for elevated tritium sample results).**

Draining from the berm area was noted in IR# 447240 on 1/29/2006. There had been 0.75 inches of precipitation from 1/28/2006 through 1/29/2006. Radiation Protection technicians had removed one of the installed berm drain plugs to remove water from the berm. The berms are equipped with drain plugs to facilitate the draining of the berm. The water was sampled prior to release and found less than the on-site LLD of 1670 pCi/L. However, the five samples prior to this drain were above LLD, and the sample that afternoon was also above on-site LLD (See Attachment 8 7 FRAC Tank Farm #1 Berm Tritium Samples). It is suspected that the cause of the inconsistent sample analysis is due to the berm water is not mixed prior to sampling. IR# 468004 was generated by the RCIT to investigate this issue. The assignment for installing sample wells and remediation of spill location (CA 1) will also address this potential concern.

Between 1/29/2006 and 2/23/2006, multiple berm samples were taken and tank transfers occurred. Tritiated water remained in the berm, with additional precipitation occurred and the berm area was not pumped down. No additional causal factors were identified in this timeframe.

On 2/23/2006, at 1300, a berm sample was obtained and analysis completed on the afternoon shift the same day (See Attachment 7 for FRAC Tank Farm #1 Berm Tritium Samples). The technician recognized the results as being very high and immediately contacted RP (went to RP office) and paged Chemistry Supervision. Chemistry and RP technicians reviewed the sample results in the chemistry counting room and RP obtained a copy of the sample results. At approximately 2000, a Radiation Protection Supervisor contacted Chemistry to have four additional samples obtained/analyzed. The RP Supervisor requested the samples be collected from each of the four corners of the berm. Between 2000 and 2130, one of the chemistry technicians discussed the elevated sample results in the berm around FRAC Tank Farm #1 with operations personnel. The operations personnel investigated and identified a 20-drop per minute

leak from FRAC tank 258741 at the drain valve pipe stub threaded connection. The requested samples of the FRAC Tank Farm berm were taken at approximately 2130. The midnight shift chemistry technicians completed the analysis at 0435. The highest sample result in the FRAC Tank Farm #1 berm following the leak was 5,720,000 pCi/L and this was not unexpected due to the identified leak of tritiated water. Chemistry samples of the leaking FRAC Tank (#258741) indicated levels of 95,479,000 pCi/L for tritiated water inside the FRAC Tank. Based on this investigation, this was the only documented event that accounts for the elevated tritium in the berm area on 3/13/2006 **(~~Causal Factor #6 – Contributing Cause #4~~Causal Factor #6 – Contributing Cause #3)**.

MMD and RP were dispatched to the FRAC tank berm to remove the insulation and verify the leak location. The leak location was verified to be from the drain valve pipe stub on FRAC tank #258741. RP and MMD constructed a catch container from a plastic 55-gallon drum and placed it under the leak at 2230. This contained all subsequent leakage and prevented additional leakage from entering the FRAC tank berm. The MMD Supervisor did not feel comfortable attempting the repair on night shift because of limited lighting. The repair was deferred to the following day shift, 2/24/2006. The Ops Field Supervisor generated IR # 457993, however he only identified the leakage concern and ~~failed~~ did not ~~to~~ include the elevated tritium concern originally raised by the Chemistry Technician. Subsequent screening of this issue by the Shift Manager, the Station Ownership Committee (SOC) and the Management Review Committee (MRC) failed to question the potential for tritiated water in the berm area. In addition, the FRAC tank leak was identified on the 2/24/2006 POD Operations Department Concerns/Activities, yet no one challenged the need for sampling or berm water remediation **(Causal Factor #2 – Root Cause #2)**. Tritium sample results from 2/23/2005 indicated tritium levels in the berm area of up to 5,720,000 pCi/L.

On 2/24/2006, shift 3, the Chemistry Technician that identified the elevated tritium levels on 2/23/2006 questioned the status of FRAC tank berm water. During interviews with this individual, he indicated that he believed that Chemistry management was unaware of the status of the leakage and gave the technician the impression that this was not a chemistry related issue since RP had ownership for addressing the water in the berm **(Casual Factor #4 – ~~Contributing Cause #2~~Contributing Cause #1, repeated)**.

The RP Duty Manager reviewed the sample results on 2/24/2006. They were elevated, so he contacted the tritium team about getting a flange or multiple flanges removed from the top of a tank to allow pumping of the berm into the tank. He contacted the RP Supervisor who last pumped out the berm for details, including the location of the pumping equipment and the process used. The next day flanges were not removed and the RP Duty Manager contacted Tritium Project Management and asked to have the flanges removed. The flanges did not get removed and the RP Duty Manager did not know if the berm was ever pumped. The Root Cause Investigation Team's review of data and interviews indicates that the berm was never pumped to a FRAC Tank **(Casual Factor #4 – ~~Contributing Cause #2~~Contributing Cause #1, repeated)**.

A key contributor to the failure to remediate the water in the berm area was that IR# 457993 was closed to the Shift Manager's follow-up response that "the leak was repaired 2/24/2006". There were no additional actions assigned to sample or pump the

bermed area in response to the identified leakage in the IR. Interviews with the Project Manager overseeing the FRAC Tank Farm, determined that ~~this individual~~he was concerned with FRAC tank water inventory, and decided that pumping the berm to the FRAC tanks would not be pursued **(~~Causal Factor #6 – Contributing Cause #4~~Causal Factor #6 – Contributing Cause #3)**.

The Unit 2 track way FRAC tanks contents were transferred back to the plant Radwaste Release Tanks (0WX01T and 0WX26T) on 2/25/2006 and 2/26/2006, respectively.

Installation of FRAC Tanks into the Steam Generator Replacement Project (SGRP) building began in mid-February 2006. This installation is known as FRAC Tank Farm #2 and was intended to contain up to an additional 8 tanks. Transfers to FRAC Tank Farm #2 must be accomplished via a tank in FRAC Tank Farm #1 to a tank in FRAC Tank Farm #2. Transfers to FRAC Tank Farm #2 began 3/9/2006.

Initial set-up and ~~T~~testing of the suction header and hose from FRAC Tank Farm #1 to FRAC Tank Farm #2 began on 3/7/2006. The RCIT identified that ~~this~~ some of the hoses had been previously used for release tank transfers. As a result, there was a potential that tritiated water may have spilled, either into ~~or outside~~ FRAC Tank Farm #1 or #2 berms. This may have contributed to the elevated tritium values in FRAC Tank Farm #1 on 3/13/2006 (RCIT generated IR# 468050 for this concern).

On Friday 3/10/2006 the Radiation Protection Manager (RPM) requested that the Duty RP Supervisor get the standing water in the FRAC Tank Farm #1 berm area pumped out. A sample of the berm water was performed and the results showed greater than on-site LLD (south end of berm, 491,000 pCi/L and north end of berm, 512,000 pCi/L) so it had to be pumped into the FRAC tanks. The Duty RP Supervisor realized that the activity was greater than on-site LLD when he reviewed the tritium analysis results on Saturday, 03/11/2006. The Duty RP Supervisor did not pump out the berm as instructed due to perceived higher priority work nor did he communicate his decision to other station management **(Casual Factor #5 – Contributing Cause #2~~3~~)**.

The Duty RP Supervisor that was tasked with pumping out FRAC Tank Farm berm #1 appeared to have a mindset accepting the presence of tritium in the berm. This was supported during interviews when the Duty RP Supervisor was not surprised by a sample result greater than on-site LLD. This was also supported through the interviews of the Radiation Protection Technicians. Based on interviews, there was a general acceptance of water in the berm by RP supervisors and technicians. **(Casual Factor #2 – Root Cause #2)**.

On 03/13/2006, at approximately 1000, an Operations Field Supervisor performed a visual inspection on FRAC Tank Farm #1. He noted no degraded conditions.

On 03/13/2006, at approximately 1015, the Radwaste Coordinator performed a visual inspection on FRAC tank Farm #1. He noticed the traffic barrier suspending the transfer hose above the berm was knocked down and the transfer hose was lying across the berm wall with no leakage occurring. This was potentially caused by high winds experienced during inclement weather (47 mph wind gusts per the metrological tower on the day of the event) **(Causal Factor #1 – Root Cause #1)**. He notified the Duty RP

Supervisor that the hose was down and there was no leakage from the hose or the berm. The Duty RP Supervisor directed the Radwaste Coordinator to notify maintenance to place the hose back on the traffic barrier **(Casual Factor #4 – ~~Contributing Cause #2~~Contributing Cause #1, repeated).**

On 03/13/2006, at approximately 1145, the Operations Field Supervisor reported to Radiation Protection the south side of the berm wall that surrounds the FRAC tanks was down allowing water to escape from FRAC Tank Farm #1. RP and Mechanical Maintenance personnel responded to the area. The south wall of the berm was immediately placed in the upright position and reinforced with sand bags on both the interior and exterior side of the berm wall **(Causal Factor #1 – Root Cause #1, repeated).**

Water samples were pulled from the two areas of surface water identified as possible over flow areas from the berm failing. An estimate of water that leaked from the berm was performed and the result was 280 gallons. Based on flow capacity of the pumps it is estimated that 240 gallons of water was pumped back into the berm. The initial water sample results were 183,000 pCi/L. Sample results from the off-site laboratory determined that the highest level of tritium in the soil samples was 122,543 pCi/L (See Attachment 6 for FRAC Tank Farm#1 soil and water sample results).

On 3/13/2006, at approximately 1730, the pump down of the puddles to the berm area was completed. In addition, absorbent material was used to dry the puddles on the ground. An additional four gallons of water was captured using absorbent material. MMD performed a follow-up inspection of the berm walls and made adjustments to the robustness of the walls by installing additional sandbags. RP performed a follow-up inspection of the berm walls and found them to be satisfactory.

On 3/13/2006, shift 3, follow-up water and soil samples were taken within a 300' radius of the FRAC farm. All standing water within a 300' radius were sampled; there were 13 samples obtained including two samples pulled in the north run off ditch by the site boundary area (See Attachment 6 for FRAC Tank Farm#1 soil and water sample results). MMD installed a scaffolding rack to support the transfer hose over the berm wall and anchored the berm wall to the M&O concrete pad.

FRAC Tank Farm Design and Installation:

The FRAC tank installation on the M&O pad (FRAC Tank Farm #1) was an accelerated project. Lessons learned from Clinton were solicited for the Braidwood installation: 1) proximity next to high power lines inducing static arc down to tanks, 2) installation of HEPA filters on vents, 3) posting of the tanks as a Radiologically Controlled Area (RCA) and Contaminated Area (CA) on the hatches that allow access, 4) posting the berms as an RCA, 5) indicating that the berm will hold rain/snow water, 6) suggesting an unconditional release plan for the water, 7) ensuring adequacy of pump equipment and disposal equipment in a staged manner to facilitate water removal from berm, 8)sampling, and 9) manner of running hoses for filling purposes to minimize risk of a contamination spread. In addition, a copy of a radiological technical evaluation was provided on placing the tanks outside. It discussed issues for potential of unmonitored airborne and water releases through storm drains, etc. These lessons learned were reviewed and incorporated into the project as deemed appropriate. Creation of the

procedures and processes to address water in the berm were the only pending actions at the completion of the Engineering Change for the FRAC Tank Farm #1 installation **(Causal Factor #3 – Root Cause #3).**

Emphasis on the berm design was based on vendor expertise and onsite engineering support to determine the height of the berm. During the design of the FRAC tank installation, Design Engineering specified a berm be used to capture incidental leakage, i.e. secondary containment device. The focus of the engineering effort for the berm consideration was to determine the volume of water as a result of a single failure, i.e. loss of one tank coupled with water accumulation as a result of rain and snow conditions. The design assumptions were that any water entering the berm would be addressed in a timely manner.

The berm itself consists of a waterproof material whose construction is designed to collapse for truck traffic to drive over the berm wall to stage tanks. A pop up "A" frame support wall is built into the material and located in the outer perimeter of the berm and is designed to stay up based on hydrostatic pressure inside the berm. However, if the intent is to keep the berm dry, then proper anchorage is required to keep the wall from collapsing from the outside--in due to the lack of hydrostatic pressure and presence of other contributors such as wind loading, presence of hoses, etc **(Causal Factor #1 – Root Cause #1, repeated)**. The outside of the berm has grommets to facilitate anchorage of the berm around its outer perimeter after all the containers/tanks are located on the berm floor and truck traffic is complete. The vendor recommends that the berm be sandbagged or staked down per the owner's manual provided to the site.

Further discussions with the vendor during this investigation concluded that the use of sandbags is intended for temporary means to accommodate truck traffic. The vendor does not recommend long-term use of sandbags for securing the berm walls, since the sandbags do not adequately prevent tangential movement of the berm wall towards the interior of the berm structure. However, the instructions provided with the berm did not provide this additional guidance. The berm installed at FRAC Tank Farm #1, was installed with sand bags placed approximately every 10 feet on the exterior, and no anchorage to the concrete pad provided **(Causal Factor #1 – Root Cause #1, repeated)**.

The original design and installation of the berm accounted for a sufficient amount of transfer hose to be located inside the berm and the hose to be moved within the berm from tank to tank. EC 358725 specified "field route" hose. As a result, the transfer hose that crossed the berm wall at one point was to be fixed with no further movement anticipated across the berm wall. However, because of kinks in the hose, the hose ended up being transitioned across various points along the berm wall. There were no specific installation recommendations for the support or routing of the transfer hose. MMD improvised the use of the traffic barrier during subsequent transfer hose moves **(Causal Factor #1 – Root Cause #1, repeated)**.

Engineering sized the berm to account for volume of water in the event of the failure of a single tank (12 inches) plus four inches of water resulting from accumulated water and snow. The berm size includes two inches of design margin. Once these sizing details were determined, the engineering effort for the berm was considered complete.

Engineering reviewed the Engineering Change Design Change Package Modification (EC DCP MOD) in accordance with the requirements of *Technical Task Risk/Rigor Assessment, Pre-Job Brief, Independent Third Party Review, And Post-Job Brief* (HU-AA-1212), Rev. 0, Attachment 1~~ and one or more risk factors were applicable~~. Therefore HU-AA-1212, Attachments 2 and 3 were performed and two compensatory actions were implemented: 1) the EC was to be reviewed by the appropriate Subject Matter Experts (SMEs) due to a concern for knowledge and experience of the Design Engineers and 2) Design Manager oversight with review by SME, Operating Experience (OPEX) due to this being first-time and non-routine design change. No berm specification was prepared by Engineering. A requisition to procure the berm was prepared by Supply Management, as directed by Project Management, with a description of the berm itself such as part number, type and size contained therein. Supply Management procured the berm as a stand-alone package.

With respect to actual berm installation, engineering felt that this was based on the vendor's recommendation, with the vendor being the expert on his berm design. The owner's manual that was obtained by Project Management was a set of simple instructions. Neither the design nor construction of the berm challenged the ability of the berm to withstand postulated environmental conditions for outside locations. ~~, t~~The inherent design of the berm inclusive of the "A" frame support wall ~~or~~ and the postulated failure modes of the berm relative to loss of tritium water outside the controlled area were not considered **(Casual Factor #1 – Root Cause #1, repeated)**. Several processes could have challenged the design and construction of the berm, yet did not. These processes include: design change, project planning, work instructions for berm installation, physical installation of the berm, numerous walkdowns by various station departments and in all levels of the organization. The reasons these processes failed to recognize the potential failure of the berm were that the individuals involved in the review, installation and oversight processes lacked two basic pieces of information: the inherent design of the "A" frame support wall and the actual level of tritium present in the FRAC Tanks **(Causal Factor #2 – Root Cause #2).**

During the conceptual design, one of the options considered was to utilize a mobile outside building to house FRAC Tank Farm #1. The major consideration for using such a building was temperature control as opposed to protection of other weather related conditions such as snow or rain, or containment of potentially radioactive fluid. The project Team opted to use heaters inside the tanks from an economic standpoint and because delivery and installation of the outside building was too close to the time when water would be pumped to the first FRAC tank. ~~Additionally, due to limitations of t~~The available pre-fabricated building was limited because ~~, the fact it would~~ it would only accommodate 9 FRAC tanks, and the station's need was for up to 13 FRAC tanks for temporary storage of tritiated water. Therefore, with insufficient storage capabilities, little time margin, and economic considerations, the outside building structure option was eliminated from further consideration.

Review of the completed Temporary Configuration Control Package (TCCP) for the FRAC Tank Farm #1 installation, including the berm, concluded that remediation of the water, addressing the presence of potentially tritiated water due to leaks/sampling, and routine sampling and monitoring of the berm were noted as issues, but needed to be addressed elsewhere. Maintenance, Operations, and Radiation Protection

departmentally reviewed the EC for the FRAC Tank Farm #1 installation; however, this EC was not reviewed by Chemistry. Creation of the sampling and monitoring ~~of~~ plan for the berm ~~were~~ was not created as ~~expected~~ specified in the EC **(~~Causal Factor #3 – Contributing Cause #1~~Causal Factor #3 – Root Cause #3, repeated)**. Failing to create the sampling and monitoring processes placed the station outside the intent of the EC for the berm.

PORC members, responsible for the review and approval of the FRAC tank installation onto the M&O pad (EC 358725-00) were interviewed. The PORC reviewed the capability of the berm to contain the volume of water resulting from a tank single failure, which accounted for a 12 inches height in the berm plus an additional four inches of water as a result of rain and melted snow and two inches margin. When the project team initially went to PORC, a significant amount of information was missing which prompted PORC to request a re-presentation – the PORC was re-convened later that same day, and final approval was given with additional actions needed. The PORC members felt that although this particular project was on a fast track, it was not any less rigorous than other PORCs.

During the PORC, most of the questions centered on topics such as how much water in the berm was acceptable, if any; what were the specifics with respect to the sampling process to be employed; and what was the means of water disposal. There was no discussion of the failure modes of the berm itself or postulated weather conditions other than temperature that could affect the FRAC Tank and berm. Also noted during this review of the PORC meeting minutes was that the requested actions of the PORC members were not dispositioned in the meeting minutes or tracked to completion with action items – IR# 468002 was generated to review this concern. Based on interviews of PORC members, it was also determined that individuals in PORC accepted responsibility for actions as a result of the PORC, yet failed to carryout those actions. Specifically requested by the PORC was development of a sampling/monitoring plan for the berm area and these actions were accepted by Chemistry yet as of 3/23/2006 have not been implemented **(~~Causal Factor #3 – Contributing Cause #1~~Causal Factor #3 – Root Cause #3, repeated)**.

FRAC Tank Operations

Transfer of water from the Station Release Tanks (0WX01T and 0WX26T) to FRAC Tank Farm #1 is performed in accordance with *Liquid Release Tank 0WX01T Transfer To Temporary Storage Tank* (BwOP WX-501T4), and *Liquid Release Tank 0WX26T Transfer To Temporary Storage Tank* (BwOP WX-526T4). Transfer of water from the FRAC Tank Farm #1 to FRAC Tank Farm #2 is performed in accordance with *Transferring FRAC Tanks To A FRAC Tank* (BwOP WX-601). Transfer of water from the FRAC tanks back to a liquid release tank 0WX01T or 0WX26T is performed in accordance with *Transferring A FRAC Tank To Liquid Release Tank 0WX01T Or 0WX26T* (BwOP WX-600). A review of these procedures determined that the release tank transfers were identical with the exception of valve numbers from either the 0WX01T or the 0WX26T. These procedures are segregated into five sections.

Section A is the Operating Department responsibility for the Radwaste Operator to gather information on the release tank to be transferred and to verify that the transfer hoses are in place to the FRAC tank to be filled.

Section B is the Chemistry Department responsibility to obtain samples from the release tank, determine if a chemical addition needs to be made to the release tank for proper chemistry control, verify isotopic content and concentrations, and provide this information to Operating and Radiation Protection.

Section C is the Radiation Protection responsibility to review the isotopic contents of the release tank, the isotopic concentrations, and determine the total number of curies of radionuclides to be released for Radioactive Effluent Tracking Dose Assessment Software (RETDAS).

Section D is the Operating Department responsibility to verify the release tank transfer system is aligned and ready for water transfer to the FRAC tanks. BwOP WX-501T4 and BwOP WX-526T4, step D.2 has a bulleted step to obtain RP concurrence that adequate catch containments or equivalent are installed under/on all hose connections not already contained inside a bermed area. This procedure guidance~~requirement allows any~~permits leakage within the bermed area to be uncontained and drip into the berm area and thereby allows the berm area to become the primary containment boundary **(Casual Factor #2 – Root Cause #2, repeated)**. CA 16 created to revise the applicable procedures (See Other Issues section).

Section E is the Operating Department responsibility for actually transferring the contents of the liquid release tanks to the FRAC tanks. This section is multi-functional. The section begins by verifying or repositioning various valves in the discharge path between the release tank and the FRAC tank. A potable water pressure test is performed to identify any leakage in the discharge path and complete any repairs of the identified leaks before continuing. Once all leaks are repaired, the potable water source is disconnected. The discharge path is then aligned and prepared for release tank transfer to the FRAC tanks. Shift Manager authorization for transfer is obtained and the transfer is started.

Investigation Interviews

Interviews with Operating Field Supervisors and Non-Licensed Operators (NLO) were conducted to determine what actions the operators performed during the water transfer. Three NLOs are used during the transfer. One NLO is the Radwaste Operator located in the Radwaste control room. A second NLO monitors the discharge hose from the liquid release tank inside of the Turbine Building up to the discharge hose exiting through the wall of the MUDS Room. The third NLO monitors the discharge hose from the MUDS room to the FRAC tank and the FRAC tank level. The Field Supervisor is present during the water transfer and also monitors the discharge hose and the FRAC tank level. At any sign of leakage, the Radwaste Operator is notified to stop the release tank pump and the leakage was to be contained.

Radiation Protection technicians are also present during the release tank transfer. The technicians monitor for area radiation during the transfer, monitor the discharge hose, and assist as necessary to control any identified leaks.

Following the completion of the release tank transfer, Section E of the referenced procedures provides guidance for the flushing of the discharge hose. Again, potable

water is connected to the discharge hose and the potable water flows through the hose. The procedures do not specify an amount of water, flowrate, or time of flushing. The Field Supervisors have specified a change in tank level to determine the amount of flushing. The operators stop the release tank transfer two inches below the maximum fill mark for the FRAC tank. The remainder of the tank is filled to the maximum fill mark with the flushing water. The estimated amount of water for a one-inch level change in a FRAC tank is about 168 gallons/inch. The discharge hose from the release tanks to the FRAC tank is about 1050 feet of two-inch diameter hose. The amount of water volume in the hose is about 171 gallons. Thus, a two-inch level change would represent a flush of two line volumes. The RCIT determined that two-inch level rise might not be adequate to thoroughly flush the discharge hose from the release tank to the FRAC tank (Reference IR# 468050 was generated by the RCIT for the immediate concern). **(Casual Factor #3 – Contributing Cause #1, repeated)**

After flushing, the procedure provides guidance for draining the discharge hose if desired. Due to the layout of the discharge hose (under a fence, over piping, through walls), the ability to lift the hose and drain the water from the hose is not feasible due to many loop seals in the hose. Thus, the hose is never drained. Since the hose is heat traced, the water left in the discharge hose is not a concern.

Transfer of water from FRAC Tank Farm #1 to FRAC Tank Farm #2 is performed per BwOP WX-601. This procedure is again arranged in sections by step. Step F.1 is a preparation to ensure both FRAC tanks are aligned for the transfer of water. Step F.2 performs a potable water leak check of the discharge hose between the FRAC tanks. If the leak check is satisfactory, then the water transfer may occur. If the leak check identifies any leakage along the discharge flow path, then the step evaluates the amount of leakage. A CAUTION before step F.2.d.10 states that if any leakage develops in the FRAC tank transfer hose, fittings, or as directed by Radiation Protection, evaluate if the transfer can continue based on the leak rate and the ability to contain the leakage (CA 16 created to revise procedured, see Other Issues section). Thus, the procedure allows for some leakage during the transfer of water from FRAC to FRAC. If the leakage is not acceptable, the leaks are repaired before continuing with the water transfer. The remainder of step F.2 completes the transfer of water from FRAC to FRAC.

BwOP WX-601 step F.3 provides guidance for flushing the FRAC to FRAC discharge hose with potable water. The FRAC to FRAC discharge hose is about 1300 feet long of two-inch diameter hose. This amount of hose represents about 212 gallons of water inside of the discharge hose. Using the same criteria as the release tank transfer flush, the two inch FRAC tank level increase represents less than two line volumes of flushing. The two-inch level rise may not be adequate to thoroughly flush the discharge hose from FRAC tank to FRAC tank (IR# 468050 generated by RCIT to review this issue). Step F.4 performs a drain of the FRAC to FRAC discharge hose using compressed air to blow the hose dry back to the FRAC tank. This step is normally performed due to the hose being un-insulated and the cold temperatures causing the hose to freeze. The remaining steps of the procedure restore the lineup of the FRAC tanks for a future transfer.

Transferring water from a FRAC tank back to a release tank is performed using BwOP WX-600. This procedure is similar to BwOP WX-601, except the FRAC tank transfer pump is aligned to the release tank discharge hose. Leak checks are performed prior to the actual transfer of water similar to BwOP WX-601. Flushing with potable water is also performed. Again, the flushing may not be adequate to thoroughly flush the hose. IR# 468050 has been generated to document this condition.

During initial setup for transferring water from FRAC to FRAC using BwOP WX-601, the hoses, fittings, and manifolds were tested for leakage. During the testing with potable water, multiple leaks were identified as documented in IR# 462800. During this leak check, the personnel believed that tritium was not an issue because the water used for testing was potable water and the hoses, fittings, manifold, and transfer pump were all new and therefore not contaminated. Interviews with operators and questioning of the design engineer identified that some of the discharge hoses were not new and were reused from the original setup with the FRAC tanks located in the Unit 2 Turbine Building track way. Since these hoses were used to transfer water from the release tank to the Turbine Building FRAC tanks, the inside of the hoses may have been internally contaminated with tritium. Some of this water was spilled within the berm area ~~and potentially where any leaks occurred along the discharge hose route between the FRAC tanks~~ (IR# 468050 generated by the RCIT to address the immediate concern) **(Casual Factor #3 – Contributing Cause #1, repeated)**. Transfer hose fittings were contained within bags and placed over catch containers, therefore leakage outside of the berm is not a concern.

During periods when water transfer is not in progress, the FRAC Tank Farms are walked down by NLOs during their outside rounds. The FRAC Tank Farms are checked once per 12 hour shift. The NLO checks for integrity of the berm and for any leakage on the FRAC tanks, hoses, recirculation pumps, tank heaters, and water level within the berm. Interviews with NLOs and Field Supervisors determined that during actual transfers of water between release tanks and FRAC tanks or FRAC to FRAC, the operators are very cognizant of leakage anywhere along the transfer route. All water is considered tritiated unless proven otherwise. During normal rounds when transfers are not occurring, the Field Supervisors always considers any water within the FRAC tank berm to be tritiated. The general attitude of the NLOs varies. Some NLOs considered the water in the FRAC tank berm to be tritiated and others believed that the water was just rainwater and not an issue **(Casual Factor #2 – Root Cause #2, repeated)**.

During operator rounds, any water inside of the berm area is reported to the Field Supervisor by the NLO. Since the NLO does not remove the water from inside of the berm, the NLO does not pursue the issue any farther after reporting the berm water condition. The Field Supervisors believe no action is required with less than four inches of water in the berm. A zero water tolerance was not instilled within either the Field Supervisors or the NLOs. The reasoning given was that the rounds allow up to four inches of water to be inside of the berm before action must be performed to remove the water. This reasoning was based on the EC for FRAC Tank Installation accounting for the presence of up to four inches of water to allow for sufficient margin to contain one FRAC tank failure **(Causal Factor #2 – Root Cause #2, repeated)**.

Interviews were conducted with maintenance personnel. These individuals have been involved during the installation, transferring of FRAC tank contents and repairs of various identified leaks throughout the process, since the initial pre-fabrication of the fittings and hoses for the original set up of the FRAC tanks in the U2 track way. Maintenance has been called on throughout the FRAC tank installation and operation of the water transfer system to move components such as fill hoses, tygon level indicators, and suction connections or to repair identified issues with the berm area or hoses.

The interviews determined that standing snow or water was present in the berm area of FRAC Tank Farm #1 during times when maintenance went to the tank farm. Those interviewed also thought that since the water was allowed to stand in the berm area the presence of the water was acceptable. The interviewees indicated that RP had on occasion, directed the use of grating or other devices, when work was required in the berm area with water present to prevent exposure to potentially tritiated water **(Causal Factor #2 – Root Cause #2)**.

Root Cause Investigation team review of the berm area tritium sample data sheets from 1/10/2006 through 3/14/2006 indicates that numerous tritium samples have been greater than on-site LLD, yet only a single IR (IR# 445016 generated 1/21/2006) was ever written to document this condition (See attachment 6 for FRAC Tank Farm #1 tritium sample results) **(~~Causal Factor #6 – Contributing Cause #4~~Causal Factor #6 – Contributing Cause #3)**.

Calculations were performed by the RCIT to determine if requirements for posting a radioactive material area was met inside the berm. The requirement is 10 times the levels stated in 10CFR20, appendix C. This calculation was performed by a Braidwood Senior Health Physicist and verified by the Radiation Protection Technical Manager. This calculation determined that the limits requiring posting as a radioactive material area was not met and no posting was required. The requirements of *Radiological Postings, Labeling, And Markings* (RP-AA-376) and *Radioactive Material (RAM) Control* (RP-AA-500) were met.

~~Eight chemistry technicians were interviewed regarding their participation in sampling of the FRAC tank and the berm area to determine their understanding of the sample process/results and how/who the sample result information was communicated. This review was performed to determine if the sampling process contributed to the tritium in the berm area and the knowledge/sensitivity of the individuals with regard to the sample results **(Causal Factor #2 – Root Cause #2, repeated)**.~~

General Chemistry sampling is performed utilizing the *Sampling* procedure (CY-AA-110-200), *General Liquid Sampling* procedure (BwCP 600-1), and *Tritium Sample Preparation and Analysis* (BwCP 220-2). Additionally, for FRAC tank sampling Chemistry had developed a "chemistry aid" #124 and #125 for locating the FRAC tank sample points at the Unit 2 turbine track way/pad north of MUDS and at the M&O Warehouse respectively. The procedures listed do not provide any specifics regarding the FRAC tank sample process **(~~Causal Factor #3 – Contributing Cause #1~~Causal Factor #3 – Root Cause #3Causal Factor #3 – Root Cause #3)**.

Interviews with the chemistry technicians identified that all procedure requirements regarding sample collection and analysis were followed, and the process of obtaining a sample most likely did not contribute to any FRAC tank water (tritium) being introduced into the berm area. Procedure BwCP 220-2 includes a step to enter the sample results into a computer "database". FRAC tank and berm tritium samples did not have assigned data points in the "database"; therefore this step was not performed (IR# 469975 generated by the RCIT to investigate this concern). The results not being entered into the "database" did not have any impact on the event, but may have provided for trending of the results if the information was entered and used.

Berm samples were performed upon request of either the Chemistry Supervisor or Radiation Protection. The technicians stated that prior to obtaining a berm sample, they would contact RP for authorization to obtain the sample but RP was not in attendance during sample collection. The berm samples were obtained either by dipping a bottle directly into the water, using a cup to dip the water to fill the sample container, or using a "turkey baster" to place the water in the container. Sample location was dependant on the amount of water in the berm, but the technicians attempted to obtain more than one berm sample from opposite ends due to there being no mixing in the berm. The technicians who had performed berm samples all discussed utilizing good radiological controls in obtaining the berm samples.

When questioned on acceptance criteria for the samples, Chemistry Technicians stated that no criteria for samples or additional/immediate actions were specified **(~~Causal Factor #3 – Contributing Cause #1~~Causal Factor #3 – Root Cause #3Causal Factor #3 – Root Cause #3)**. Some technicians stated they analyze the sample and RP evaluates the results per *Unconditional Release Survey Method* (RP-AA-503) to determine action. The technicians stated that once the berm area was ~~sampled~~ analyzed as containing tritium, subsequent samples would be expected to be greater than on-site LLD; therefore the technicians would not make any immediate notifications. All technicians stated that sample results were documented on BwCP 220-2T1 and then placed the datasheets in the counting room mailboxes. Which mailbox that the sample results were placed in, RP or Chemistry, varied depending on the technician interviewed. Placing the sample results in the Chemistry mailbox further delayed the review of the sample results **(~~Causal Factor #4 – Contributing Cause #2~~Causal Factor #4 – Contributing Cause #1)**.

Two chemistry supervisors were interviewed on their involvement with the process. The Counting Room Supervisor stated that his involvement was to review the BwCP 220-2T1 datasheets. He stated that he reviewed them to ensure the calculation was "sensible". When questioned on the acceptance criteria for the samples, this supervisor stated the station has an on-site LLD value and he would recognize if a sample were greater than on-site LLD. When questioned on what the expected response is for a sample greater than on-site LLD, the supervisor stated the first ~~one~~ sample from 1/21/2006 was a concern and the response was to immediately notify RP and discuss the event with the environmental group. Following the 1/21/2006 event, there was no information of the leak being repaired or the berm being cleaned, therefore the expected sample ~~result~~analyses would be greater than on-site LLD **(~~Causal Factor #3 – Contributing Cause #1~~Causal Factor #3 – Root Cause #3)**.

The Counting Room Supervisor stated that Chemistry produces the results and RP reviews them for Unconditional Release standards in accordance with RP-AA-503. When questioned about tritium sample results being reported to RP, the supervisor stated a process change had been implemented due to the datasheets not being returned to chemistry in a timely manner (IR# 292053). The response to the IR was datasheets BwCP 220-2T1 would be reviewed by RP in the Chemistry office and remain in the lab to assure record retention requirements were met. Based on the interviews with the chemistry technicians and supervisors and datasheet retrieval for this investigation (some datasheets were in the RP office and one could not be found), this was not always the actual practice (IR# 468960 generated to resolve this issue). As of 3/16/2006 Chemistry is required to contact RP as soon as the sample results are completed, per the acting Chemistry Manager **(~~Causal Factor #3 – Contributing Cause #1~~Causal Factor #3 – Root Cause #3)**.

The Chemistry Lab Supervisor interview identified the following. In the development of the FRAC Tank Farm, the chemistry support was to sample the FRAC tanks after each one was filled and to check FRAC tank level on a monthly basis. On 1/11/2006, an informal process for sampling of the berm was established. A RP supervisor was the lead on this and stated a sample was to be pulled on a weekly basis or upon request. Samples would be requested every time someone would be entering the berm area. The Chemistry Lab Supervisor did not establish a weekly sample routine because requests were being made to sample often, almost daily in the beginning due to ongoing work in the area. The process was set up such that the RP supervisor would contact the Chemistry Lab Supervisor and he would instruct the Chemistry Technicians to perform the sample. There were instances where RP called to obtain the results of the sample but this did not always happen and Chemistry would get the information to RP in a variety of ways; sometimes via a call or a page or by placing a copy in the counting room mail slot. There were also times that the datasheets were placed in the chemistry mail slot in the counting room. The Chemistry Lab Supervisor would review these sheets, which he stated he used the initial berm sample results as a baseline for his review. The supervisor stated if he recognized a sample as being high, he would have copied the sample results for RP or the Environmental Supervisor. He believed approximately 6 were sent to RP after his review. After approximately 3 weeks the requests for berm samples slowed, due to all the FRAC tanks being installed. Although the frequency of the berm sample requests had slowed there was no routine established for performing this sampling on a weekly basis **(~~Causal Factor #3 – Contributing Cause #1~~Causal Factor #3 – Root Cause #3)**.

On 3/13/2006, the Chemistry Lab Supervisor was providing a tour of the FRAC Tank Farm for 3 counterparts from other sites. Upon entering the FRAC tank area he noticed that the fill hose appeared to be sagging onto the berm. Upon closer investigation he identified a road barrier lying under the hose near the berm, and he assumed that the barrier had been holding the hose in place and had been blown over by the high winds. He assessed the area, finding the hose in contact with the berm and the berm leaning inward. No water was flowing from the bermed area and he did not want to upright the berm due to "radiation" concerns with the water. He proceeded to the Condensate Polisher room and attempted to contact RP, the RP line was busy. He then contacted the Tritium Team Project Manager to request assistance. He stated he explained the condition of the hose and berm to the Tritium Team Project Manager and requested he

contact maintenance to rectify the condition. The chemistry individual then attempted to contact RP, this time connecting with the Duty RP Supervisor. He informed the Duty RP Supervisor that the hose had been blown off the traffic barrier and the hose was on the berm with no water coming out of the berm. The Chemistry Lab Supervisor stated that the Duty RP Supervisor responded by saying he had two RP technicians going out to the FRAC tank area and they would look into the situation **(~~Causal Factor #4 – Contributing Cause #2~~Causal Factor #4 – Contributing Cause #1)**.

Identification of FRAC Tank Issues:

Overall, the personnel assigned MRC and SOC duties did not have a good alignment concerning which department is responsible for mitigating leaks on the FRAC tanks or related equipment. The answers ranged from Mechanical Maintenance Department to the Tritium/Project team. This resulted in the SOC routing issues to work groups that did not own the FRAC Tank Farm and issues went to several departments before the issues were resolved. On some occasions, issues were routed to the tritium team after the FRAC Tank Farm was turned over to the station **(~~Causal Factor #4 – Contributing Cause #2~~Causal Factor #4 – Contributing Cause #1)**.

Based on interviews, there was no clear expectation for the MRC or SOC on water remaining in the FRAC Tank Farm berm. The answers ranged from 'no water allowed in the berm' to 'up to four inches is ok, then actions need to be taken.' This resulted in confusion on how much, if any, water should be allowed in the berm **(Causal Factor #2 – Root Cause #1)**.

When screening or reviewing issues regarding minor leakage from a FRAC tank fitting, members of the SOC and MRC stated that they would expect to see the following items resolved. In general, most would ensure that the leak was repaired and the water was contained. Some would be concerned with sampling and disposition of the leakage. One stated they would process through the normal channels, like any leaking component. Another SOC member stated that they were not aware of the concentration of the contents of the FRAC tanks, so a 20-drop per minute leak into the berm didn't seem to be of any consequence due to the size of the berm (Reference IR# 457993 for the 2/23/2006 identified leak) **(Causal Factor #2 – Root Cause #1)**.

~~Sensitivity to tritium and the potential for uncontrolled release ranged from low (particularly if the leakage was contained on-site) to extremely sensitive.~~ The sensitivity level to tritium and the potential for release seemed to vary with the individual person's involvement and subsequent knowledge level in other tritium related activities. Most were extremely sensitive to the release of tritium off-site, but did not hold the same expectation for material contained on-site **(Causal Factor #2 – Root Cause #1)**.

Analysis:

Analysis techniques used during this investigation were:

- Event and Causal Factor Charting (see Attachment 1): utilized to provide a visual description of the sequence of events leading up to the inadvertent release of the tritiated water outside the FRAC Tank Farm #1 berm area.
- TapRoot®: TapRoot® analysis was utilized to analyze and evaluate the identified causal factors.

- Barrier Analysis: utilized in conjunction with Event and Causal Factor charting to identify failed or challenge barriers. Note that the performed Barrier Analysis is documented in the Event and Causal Factor chart (see Attachment 1).

Evaluation:

Problem Statement	Cause (describe the cause and identify whether it is a root cause or contributing cause)	Basis for Cause Determination
Causal Factor #1 Berm wall not properly secured so that transfer hose in conjunction with high wind degraded berm wall.	Root Cause #1 Berm design, construction and installation did not account for degrading the integral "A" frame design of the berm wall due to high winds or objects falling upon the berm wall. **(Design – Problem Not Anticipated)**	• Berm wall was installed with sandbags in accordance with the provided owners manual. • Sandbags did not provide sufficient stability to withstand severe wind loading (47 mph winds on the day of the event) in addition to the hose falling on the berm wall. • Vendor clarified that the use of sandbags is intended for temporary use – to allow truck traffic. • Engineering did not evaluate the failure modes of the berm. Engineering relied on the berm manufacturer as subject matter expert for this application. • Project Management and installers (MMD) did not question the installation of the berm using only sandbags. • Project Management and installers (MMD) did not understand the high concentration of tritium in the FRAC tanks.
Causal Factor #2 Acceptance of water and tritiated water in the berm. SOC, MRC and the POD members did not follow-up and ensure actions were properly tracked to completion (i.e. pumping of berm,	Root Cause #2 Inaccurate risk perception resulted in a lack of standards with regard to tritiated water inside of the FRAC tank berm. **(No SPAC)**	• If tritiated water had not accumulated inside of the FRAC tank berm, the collapse of the berm wall would not be of any consequence. Station personnel did not properly recognize the significance of allowing tritiated water to accumulate combined with potential failure modes of the FRAC tank berm. • The standard (fundamental) of radiological hazard recognition was

Problem Statement	Cause (describe the cause and identify whether it is a root cause or contributing cause)	Basis for Cause Determination
sampling of berm as a result of the 20 dpm leak on 2/23/06). Work standards in the FRAC tank berm were ad hoc due to limited management oversight and no clear standards defined.		not applied. After identifying the presence of tritiated water in the berm, having tritiated water in the berm became accepted as normal. The potential consequences of a berm failure was not questioned. Communications between Chemistry, Radiation Protection, Operations, and Maintenance did not question the presence of tritiated water inside of the berm. Many individuals believed the water was clean and consisted only of rainwater; others believed the water could have elevated tritium levels and accepted the tritium levels as normal. • The standard (fundamental) for intolerance of unexpected equipment failures was not applied. Water was allowed to accumulate in the FRAC tank berm. Station personnel noted the water in the berm and accepted its presence as normal and did not question if it should be there or not. The assumption was that the water was due to rain and melting snow. SOC, MRC and POD members did not question if water in the berm was acceptable. • When the 20-dpm leak was identified on 2/23/06, the IR stated that the leak was repaired and no further actions were performed. No one questioned if water was in the berm, if the water in the berm was removed, or if the spill was cleaned up. • Failure to comply with these standards resulted in the tritiated water to accumulate inside of the FRAC tank berm. Station personnel

Problem Statement	Cause (describe the cause and identify whether it is a root cause or contributing cause)	Basis for Cause Determination
		observing the water did not question its presence and the water in the berm became an accepted condition.
Causal Factor #3 No procedures were developed to address water in the berm area such as limits and pumping guidance. No procedures developed to ensure that a representative tritium concentration sample is taken. Monitoring of tritium levels were performed as requested, with no direction to perform reviews, trending or who is to be notified when chemistry samples indicate elevated tritium in the berm.	~~Contributing~~ Root Cause #~~1~~3 Standards, Policies or Administrative Controls (SPACs) not established to ensure proper monitoring and control of water in the FRAC tank berm. **(No SPAC)** These process issues would not have prevented the overflow of tritiated berm water or the collapse of the berm wall, but would have helped to establish the proper standards for Station personnel to respond to the accumulation of water inside of the FRAC tank berm area. Therefore, this causal factor is considered a ~~contributing~~ root cause.	• The standard (fundamental) for questioning attitude was not applied. The expectation of water accumulating inside of the FRAC tank berm was anticipated by various Station Departments. ~~The standard (fundamental) for condition reporting and resolution was not applied. When issues were identified concerning the FRAC tanks, the disposition of those IRs was not clearly defined. The IRs were distributed to different Station Departments for resolution rather than a common group resulting in a disassociation of corrective actions with no one group cognizant of the complete status of the FRAC tanks.~~ • The standard (fundamental) for communication was not applied. Communications between the various affected Departments was weak resulting in late information disseminated to personnel in different Departments. Chemistry sample results would be placed in mail slots to be delivered via a mail routing versus delivered to specific supervisors. Problems were not immediately relayed to the Shift Manager to initiate immediate resolution or correction of problems. • The standard (fundamental) for drive for results was not applied. The PORC expectations for procedure and process creation were not performed or tracked to completion.

Problem Statement	Cause (describe the cause and identify whether it is a root cause or contributing cause)	Basis for Cause Determination
		• The standard (fundamental) for radiological safety was not applied. The amount of water allowed in the berm was not clearly identified and the processes for periodic sampling, limits for disposal of the berm water, or removal of berm water were not established.
Causal Factor #4 Poor communication regarding turnover of the FRAC tank installation to station departments.	Contributing Cause #21 Lack of ownership for FRAC tank issues and resolution of issues from poor communication of the transition from project management to the station. **(Turnover NI)**	• There was no formal turnover of the project to the station. The project manager announced at the POD and the 0730 working meeting that the station owned the FRAC farm; this occurred on or about 3/1/2006. Site wide communication of the change of responsibilities for the FRAC Tank Farm did not occur. • The standard (fundamental) for condition reporting and resolution was not applied. When issues were identified concerning the FRAC tanks, the disposition of those IRs was not clearly defined. The IRs were distributed to different Station Departments for resolution rather than a common group resulting in a disassociation of corrective actions with no one group cognizant of the complete status of the FRAC tanks. • The personnel assigned MRC and SOC duties did not have a good ~~alignment concerning~~undestanding of which department is responsible for mitigating leaks on the FRAC tanks or related equipment. This resulted in the SOC routing issues to work groups that did not own the FRAC farm and issues went to several departments before the issues were resolved. On some occasions, issues were routed to the tritium project team after the FRAC

Problem Statement	Cause (describe the cause and identify whether it is a root cause or contributing cause)	Basis for Cause Determination
		farm was turned over to the station. • On 3/13/2006 the Chemistry Supervisor contacted the tritium team project manager to request assistance concerning the fallen berm. No one contacted the Shift Manager, the owner of the FRAC farm.
Causal Factor #5 Berm not pumped down (drained) after identification of water in the berm	Contributing Cause #~~3~~2 RP Supervisor failed to carryout the action to sample and pump down the FRAC Tank Farm #1 berm between 3/10/2006 through 3/13/2006. **(SPAC Not Used)** The basis for considering this causal factor as a contributing cause versus a root cause is that the failure to perform the requested action allowed the presence of the tritiated water to remain in the berm. Since the berm installation had the potential to degrade and limited processes existed to remove the tritiated water from the berm, the failure to act and not pump out the berm would not have prevented recurrence of this event.	• On 3/10/2006, a RP technician notified the Radiation Protection Manger (RPM) that standing water was present in the FRAC Tank Farm #1 berm. The RPM directed a RP Supervisor to obtain samples for the berm water, and then pump the water out of the berm. Samples were collected on 3/10/2006 and the results were noted by the RP Supervisor to be above on-site LLD (north side of berm at 512,000 pCi/L, south side of berm at 491,000 pCi/L). Based on interviews, the individual recognized the sample results as being above on-site LLD, but it was not noted as being unusual. Because of other work activities, such as transfer of resin and a High Integrity Container (HIC) shipment in progress, the RP Supervisor prioritized the berm pumping activity lower than other activities. At the time of the event, 3/13/2006, the berm pumping request had still not been carried out or communicated.
Causal Factor #6 ~~20~~ Multiple ~~berm~~	Contributing Cause #4~~3~~	• Routine sampling was performed prior to performing work in the FRAC

Problem Statement	Cause (describe the cause and identify whether it is a root cause or contributing cause)	Basis for Cause Determination
~~tritium~~ berm samples taken between 1/20/06 and 3/14/06 that were above on-site LLD for tritium with ~~no~~ only one IR~~s~~ generated (1/21/06 event) to document these issues. Note that on some of the sample days, multiple samples were analyzed and were above on-site LLD, yet the expectation would be to generate one IR for the days tritium analyses that were above on-site LLD. Lack of communication of the elevated tritium samples to station management prevented timely identification of an adverse trend and the berm deficient condition	Chemistry, Radiation Protection and Project Management personnel failed to generate Issue Reports to identify elevated tritium samples, presence of water in the berm area and minor leakage, which prevented proper and timely action being taken. **(SPAC Not Used)**	Tank Farm #1~~,~~. O~~o~~f the sample results taken, ~~20~~ multiple sample results indicated elevated tritium. IR# 468626 was generated by the RCIT to address the immediate concern for this issue. • The standard (fundamental) for condition reporting and resolution was not applied. Multiple samples were obtained from the FRAC tank berm with levels higher than on-site LLD, but IRs were not written. The spill of tritiated water into the berm was observed, but IRs were not written. The IRs would have alerted Station Management to the adverse trend in tritium sample concentrations in the berm and initiated the proper actions to resolve the water issue. • Interviews with various ~~station~~ Chemistry, Radiation Protection, Operations and Maintenance personnel indicated that as time went on, they perceived a greater level of acceptance for the water in the berm and the tritium concentrations. Personnel used this perceived acceptance to justify not generating additional IRs for conditions that had already been identified.

Extent of Condition:

Cause being addressed	Extent of Condition Review
Berm wall not properly secured so that transfer hose in conjunction with high wind degraded berm wall. Causal Factor #1	This condition applies to any site that would build a temporary liquid storage facility in an outside location. ATI 465719-08 was created to generate a Nuclear Event Report (NER). ATI 465719-09 was created to generate a Nuclear Operating Notification Experience (NNOE). FRAC Tank Farm #2 (SGRP Building) berm wall was discovered fallen down and standing water in the berm. IR# 466356. The Sulfuric Acid unloading station at the Braidwood Lake Screen House is the only other temporary berm configuration on site. The team inspected the berm and identified the berm was not attached to the ground. IR # 468836 was generated. Difficulties are currently being experienced associated with the ALPS system for treatment of the release water. The PORC for approval of this installation also occurred the day prior to the intended day of operation. IR# 470194 generated for this issue.
Inaccurate risk perception resulted in a lack of standards with regard to tritiated water inside of the FRAC tank berm. Causal Factor #2	This condition applies to any site that allows water or the stored liquid to build up in the berm. ATI 465719-08 was created to generate a Nuclear Event Report (NER). ATI 465719-09 was created to generate a Nuclear Operating Notification Experience (NNOE). Storage of tritiated water in the Primary Water Storage Tank (PWST) is intended to begin during 2006. Evaluation is in progress for review of tritiated water storage in plant systems (Tritium Team 3). This review is in progress at all Exelon nuclear sites.
Standards, Policies or Administrative Controls (SPACs) not established to ensure proper monitoring and control of water in the FRAC tank berm. Causal Factor #3	This condition applies to any site that would build a temporary liquid storage facility in an outside location. ATI 465719-08 was created to generate a Nuclear Event Report (NER). ATI 465719-09 was created to generate a Nuclear Operating Notification Experience (NNOE). Storage of tritiated water in the Primary Water Storage Tank (PWST) is intended to begin during 2006. Evaluation is in progress for review of tritiated water storage in plant systems (Tritium Team 3). This review is in progress at all Exelon nuclear sites.
Lack of ownership for FRAC tank issues and resolution of issues	This condition applies to any site that would build a temporary facility where clear ownership is not defined. ATI 465719-08 was created to generate a Nuclear Event Report (NER). ATI

Cause being addressed	Extent of Condition Review
from poor communication of the transition from project management to the station. Causal Factor #4	465719-09 was created to generate a Nuclear Operating Notification Experience (NNOE).

Risk Assessment:

Plant-specific risk consequence	Basis for Determination
Tritiated water outside the intended control area	The Nuclear Safety Risk Assessment showed no impact on station operation or response to postulated accident conditions. The event was not reportable under Reportability Manual, SAF 1.9, News Release or Notification of Other Government Agencies per 10 CFR 50.73.

Previous Events

Previous Events	Previous Event Review
5-4-05 – 292165, Truck Driver Acid Splash.	This event is included in this previous event section due to the significant parallel of the acid splash event to the current event being investigated. Two contributing causes were determined to collectively be the Root Cause of this investigation: The design of the acid unloading station provided a backpressure at the hose connection with a camlock fitting in place. The temporary acid delivery system installed at the Braidwood cooling lake was built ad hoc. Site Engineering was not involved in the design of the system. Although not required because the acid delivery system is not part of any installed plant systems, if the acid delivery system had been reviewed per CC-AA-102, the safety aspects of handling a hazardous material would have been addressed by the process and design features incorporated into the acid delivery system to prevent an acid splashing event. The system design / layout caused a back pressure at the acid hose connection due to an uphill run of the acid

Previous Events	Previous Event Review
	discharge hose going to the lake and the long length of hose from the acid unloading manifold to the entry point into the lake. Every acid delivery required the opening of the vent valve on the acid unloading manifold and resulted in approximately one gallon of acid being depressurized and vented into a bucket. Without a backpressure at the camlock fitting, the driver would not have been splashed with acid when the acid delivery hose was disconnected. Lack of Station ownership of required personnel safety equipment. Several deficiencies were identified by operators in the field with safety equipment and appropriate system design to ensure safety was addressed at the acid unloading station. These issues were reviewed by Station management in the SOC and MRC, but were never given a high enough priority to ensure that the safety issues were resolved; and, no Station Department would take ownership to resolve the issues. As a result, acid unloading continued without the proper safety shower functioning properly at the acid unloading station. This is a similar event, but is not considered a repeat event. ~~, since t~~ In the acid splash event, IRs were generated however, the safety aspects of the concerns were not addressed due to no ownership. The distinction to the current investigation is that no IRs were generated for elevated tritium samples. There were no actions as a result of the acid splash event that would have prevented this event.
2-28-06 – 428868, Inadequate response to unplanned environmental tritium releases from Braidwood station due to weak managerial oversight and the lack of integrated procedural guidance.	There were two root causes and two contributing causes identified during this investigation: Root Causes: • The need for a near zero leakage standard was not identified, due to a lack of Technical Rigor/Questioning Attitude. • Ineffective response was weak management review and oversight of spill response activities. Contributing Causes: • The Circulating Water Blowdown Vacuum Breaker Valves had inadequate preventative maintenance programs and inadequate design configuration. • Lack of integrated procedural guidance to ensure proper recognition, evaluation, and timely mitigation of the radiological spill events.

Previous Events	Previous Event Review
	The results of the RCR completed under 428868 have parallels to this investigation in that both identify the stations lack of questioning attitude, management oversight for tritium related activities and a failure to have procedural guidance to recognize, evaluate and respond to issues related to tritium. Identification that the FRAC Tank Farm installation was occurring during the same timeframe as this investigation, and could potentially have the same issues, was not considered during the completed RCR, nor addressed in the extent of condition section. This was a missed opportunity for the station in that the extent of condition solely looked backward in time at similar events, and not at in progress work, that may have very related issues. This is not a repeat event, in that though the two events are related (due to tritium), however, no corrective actions would have prevented this current event.
3-21-06 – News Release via email, Radioactivity Investigation at Indian Point	During the investigation of a Fuel Pool leak at Indian Point (IP2), wells were drilled to characterize ground water flow and radionuclide concentrations on-site. Some of the drilled wells were found to be above the drinking water standard of 20,000 pCi/L for tritium. Continued analysis also discovered strontium-90 above the EPA standard (8 pCi/L). The RCIT discussed this concern with the Tritium Remediation Team. Isotopic analysis, which would discover strontium-90 and other radionuclides have been performed on the monitoring wells and no additional concerns beyond tritium were discovered.

Corrective Actions to Prevent Recurrence (CAPRs):

Root Cause Being Addressed	Corrective Action to Prevent Recurrence (CAPR)	Owner	Due Date
Berm design, construction and installation did not account for degrading the integral "A" frame design of the berm wall due to high winds or objects falling upon the berm wall. Root Cause #1	CAPR 1 Secure the berm wall using anchor screws and washers through the berm wall grommets. Install a scaffold rack to support the transfer hose over the berm wall.	A8922MM	Complete

Root Cause Being Addressed	Corrective Action to Prevent Recurrence (CAPR)	Owner	Due Date
Inaccurate risk perception resulted in a lack of standards with regard to tritiated water inside of the FRAC tank berm. Root Cause #2	CAPR 2 Develop and implement a T&RM for monitoring and controlling water inside of the FRAC tank berms. T&RM will provide direction for initiating actions to remove any accessible water within the berm, check all hose connections for leakage and proper containment, monitoring frequency during adverse weather conditions, and notifications when conditions do not meet proper standards. NOTE: Additional assignments will be created to support Ops in the creation of the T&RM (See CA section to follow): Radiation Protection to provide guidance on the control and disposal of water within the FRAC tank berms based upon berm water sample results. Guidance is to be specific to ensure accessible water within the berm is removed as soon as possible with no release or tritiated water outside of the berm (CA3). Chemistry to provide guidance on tritium sampling of the FRAC tanks and the FRAC tank berm area. Guidance is to provide documentation and recording of the tritium results and the criteria for notification of the tritium levels to Station management when greater than LLD (initiate Issue Reports). Guidance is to provide the specific routing of the tritium results to applicable Station Departments within acceptable time periods for review and trending (CA 4). (Note this same action is listed in the Communication section)	A8910OP	04/07/06

Root Cause Being Addressed	Corrective Action to Prevent Recurrence (CAPR)	Owner	Due Date
Processes not established to ensure proper monitoring and control of water in the FRAC tank berm. ~~Contributing~~ Root Cause ~~#1~~3	Refer to CAPR 2	A8910OP	4/7/06

Corrective Actions:

Cause Being Addressed	Corrective Action (CA)	Owner	Due Date
Berm design, construction and installation did not account for degrading the integral "A" frame design of the berm wall due to high winds or objects falling upon the berm wall.	CA 1 Install additional sample wells to monitor tritium migration as a result of the 3/13/06 berm wall failure event. Document remediation actions (i.e. digging or sparging) performed as a result of this event.	A8901H3	5/4/06
Causal Factor #1	CA 2 Review the FRAC Tank Farm #1 berm event and the Acid Splash events with the Design Engineering peer group to evaluate for procedure revisions to CC-AA-102/CC-AA-103 in regard to potential failure modes of components installed for design margin and the hazards and assumptions for these components. In addition, determine if further evaluations should be performed when "ready to use" components are being specified. Document findings and generate additional actions as appropriate.	A8952NESPR	6/14/06

Cause Being Addressed	Corrective Action (CA)	Owner	Due Date
	CA 3 Perform a design review of the berms installed in FRAC Tank Farms #1 and #2 for potential failure modes of the berms. Document this evaluation and generate additional actions, as necessary, to address any unresolved potential failure modes.	A8952NESPR	4/14/06
Inaccurate risk perception resulted in a lack of standards with regard to tritiated water inside of the FRAC tank berm. Causal Factor #2	CA ~~3~~4 Radiation Protection to provide guidance on the control and disposal of water within the FRAC tank berms based upon berm water sample results. Guidance is to be specific to ensure accessible water within the berm is removed as soon as possible with no release or tritiated water outside of the berm.	A8931RP	~~3/31/06~~4/7/06
	CA ~~4~~5 Chemistry to provide guidance on tritium sampling of the FRAC tanks and the FRAC tank berm area. Guidance is to provide documentation and recording of the tritium results and the criteria for notification of the tritium levels to Station management when greater than LLD (initiate Issue Reports). Guidance is to provide the specific routing of the tritium results to applicable Station Departments within acceptable time periods for review and trending.	A8932CHEM	~~3/31/06~~4/7/06

Cause Being Addressed	Corrective Action (CA)	Owner	Due Date
	CA ~~5~~6 Provide interim guidance on tritiated water transfer equipment and FRAC tank Farm walk-down criteria.	A8910OP	Complete BR-60 implemented 3/23/06
Processes not established to ensure proper monitoring and control of water in the FRAC tank berm. Causal Factor #3	Refer to CAPR 2	A8910OP	4/7/06
	Refer to CA ~~3~~ 4	A8931RP	~~3/31/06~~4/7/06
	Refer to CA 45	A8932CHEM	~~3/31/06~~4/7/06
	CA ~~6~~7 Prepare a case study for this event for presentation to Station Management.	A8961TR	7/14/06
	CA ~~7~~8 Present the case study developed by Training to ~~Department Supervisors~~Station Management. The work groups are SOC, MRC, Station Duty Teams, Chemistry, Radiation Protection and Operations FLSs. (Note this same action is listed in the Communication section)	A8931RP	8/31/06
	CA ~~8~~9 Communicate to the station the ownership responsibilities for the FRAC tank installations at the Station Alignment meeting. (Note this same action is listed in the Communication section)	A8910OP	4/4/06

Cause Being Addressed	Corrective Action (CA)	Owner	Due Date
	ACIT 910 Counsel the Chemistry individuals responsible for accepting the actions to create sampling/monitoring procedures as a result of the PORC but did not perform the requested actions in accordance with the MARC principles. Document the FMS entry. In addition, review this event as a Department Clock Reset in accordance with OP-AA-101-113-1001.~~Counsel the Chemistry individuals responsible for accepting the actions to create sampling/monitoring procedures as a result of the PORC but did not perform the requested actions. Document the FMS numbers in the assignment. Review this event for department clock reset in accordance with OP-AA-101-113-1001.~~	A8932CHEM	4/14/06
Lack of ownership for FRAC tank issues and resolution of issues from poor communication of the transition from project management to the station. Causal Factor #4	Refer to ~~CA8~~CA9	A8910OP	4/4/06
	Refer to ~~CA6~~CA7	A8961TR	7/14/06
	Refer to ~~CA7~~CA8	A8931RP	8/31/06
	CA ~~10~~11 Review IR# 443611 with SOC in regard to timely action to address potential safety concerns.~~Review this issue at the SOC and MRC Alignment meeting.~~ (Note this same action is listed in the Communication section)	A8901RA	7/14/06

Cause Being Addressed	Corrective Action (CA)	Owner	Due Date
RP Supervisor failed to carry out the action to sample and pump down the FRAC tank farm #1 berm between 3/10/06 and 3/13/06. Causal Factor #5	ACIT ~~11~~12 Counsel the RP Supervisor who failed to carry-out the action to pump down the berm in accordance with the MARC principles. Document the FMS entry. In addition, review this event as a Department Clock Reset in accordance with OP-AA-101-113-1001.	A8931RP	04/14/06
Chemistry, Radiation Protection and Project Management personnel failed to generate Issue Reports to identify elevated tritium samples, presence of water in the berm area and minor leakage, which prevented proper and timely action being taken. Causal Factor #6	ACIT ~~12~~13 Counsel the Chemistry Supervisors and Technicians who failed to generate IRs for tritium samples greater than on-site LLD in accordance with the MARC principles. Refer to the Tritium Sample Analysis logs for the individuals involved in this action. Document the FMS entry. In addition, review this event as a Department Clock Reset in accordance with OP-AA-101-113-1001.	A8932CHEM	4/14/06
	ACIT ~~13~~14 Counsel the Radiation Protection Supervisors who failed to generate IRs for tritium samples greater than on-site LLD in accordance with the MARC principles. Refer to the Tritium Sample Analysis logs for the individuals who reviewed the results and were involved in this action. Document the FMS entry. In addition, review this event as a Department Clock Reset in accordance with OP-AA-101-113-1001.	A8931RP	4/14/06

Cause Being Addressed	Corrective Action (CA)	Owner	Due Date
	ACIT 1415 Counsel the Project Management individual who unilaterally decided to not pump out the berm area in accordance with the MARC principles. Document the contractor/supplier FMS entry. In addition, review this event as a Department Clock Reset in accordance with OP-AA-101-113-1001.	A8940PGMT	4/14/06

Effectiveness Reviews (EFRs):

CAPR / CA being addressed	Effectiveness Review Action	Owner	Due Date
CAPR2	EFR2EFR1 Review for effectiveness of CAPR2 in regard to root cause #2 and #3.	A8910OP	4/1/2007

Programmatic/Organizational Issues:

Programmatic and Organizational Weaknesses	Corrective Action (CA) or Action Item (ACIT)	Owner	Due Date
Failure to generate IRs for elevated tritium results	ACITs 13 through 15	A8931RP, A8932CHEM and A8940PGMT	4/14/06
SOC and MRC alignment with what department is responsible for the FRAC Tank Farm	CA 1011	A8901RA	7/14/06

Other Issues:

Other Issues identified during investigation	Corrective Action (CA) or Action Item (ACIT)	Owner	Due Date
Procedures BwOP WX-501T4, 526T4, 600 and 601 all contain guidance that permits leakage within the berm area.	CA 16 Revise BwOP WX-501T4, 526T4, 600 and 601 to include the expectation of zero-leakage.	A8910OP	4/14/06
FRAC Tank transfer hose flushes potentially inadequate	Based on interviews with operators, the criteria used to determine an adequate flush is two inches of FRAC tank level. The operators typically stop water transfer to the FRAC tank at two inches below the maximum FRAC tank level for the transfer. The remainder of the FRAC tank level is filled with potable water for the discharge hose flush. Based on the length of the discharge hoses from the release tank to the FRAC tank or between the FRAC tanks, less than or equal to two line volumes are flushed through the discharge hose. Since the hoses are considered clean after the flush, pressure testing before the next use of water transfer to a FRAC tank with potable water may not be clean water. All leakage is treated as clean water during the pressure leak testing rather than as potentially contaminated. IR# 468050 generated to investigate.	A8910OP	As established by IR# 468050

Other Issues identified during investigation	Corrective Action (CA) or Action Item (ACIT)	Owner	Due Date
FRAC Tank fill flanges not properly secured	During walkdown, it was noted that several of the FRAC tank flanges on top of the FRAC tanks are not properly secured. Of the 13 FRAC tanks in the FRAC Tank Farm #1, there are 6 FRAC tanks with only one bolt securing the fill flanges, and an additional 2 flanges that not fully covering the fill line stubs on top of the tanks. IR# 468039 generated to correct this condition under a WR.	A8922MM	As established by IR# 468039
FRAC to FRAC Transfer Pump left in an unacceptable condition	FRAC to FRAC transfer pump left in unacceptable condition. This is a concern because the pump could fall off the unstable stand while accessing the ladder next to the pump. Pump is located on M&O pad. IR# 468042 generated to correct this condition under a WR. This issue was also a potential safety concern, and the Ops Field Supervisor corrected the immediate safety concerns for this issue on the afternoon of 3/18/2006.	A8922MM	As established by IR# 468042
Limited documentation of berm draining in Radwaste and/or RP logs.	While reviewing data for the FRAC tank spill root cause it was identified there was limited documentation on when the berm was drained or pumped down. Radwaste and rad protection logs were reviewed. IR# 468008 generated to develop corrective actions. This issue is outside the scope of this investigation.	A8931RP	As established by IR# 468008

Other Issues identified during investigation	Corrective Action (CA) or Action Item (ACIT)	Owner	Due Date
No specific value or standard exists for draining of the FRAC Tank Farm berms.	While reviewing data for the FRAC tank spill root cause it was identified there is a no clear specific value or standard for the lower value of delectability (LLD) to allow draining of the berm. On site LLD analysis is 1670 pCi/L and off-site LLD analysis is 200 pCi/L. IR# 467997 generated to investigation. The RCIT recognizes that these values do factor into this investigation, however the evaluation and development of the values/standards for berm draining is outside the scope of this investigation.	A8931RP	As established by IR# 467997
Berm drained on 1/29/2006 and based on an elevation of tritium on subsequent berm samples, the station missed an opportunity to question this trend.	While reviewing data for the FRAC tank spill root cause it was identified on 1/29/06, the FRAC berm was sampled at 1055. The sample results were identified by operations and the drain was secured. A subsequent sample was taken at 1900 and the results were greater than LLD (2330 pCi/L). There was no follow-up on how the tritium level rose during the drain down. No one questioned where the tritium came from. IR# 468004 generated to evaluate this condition. The RCIT recognizes that these failures to identify issues through CAP is pertinent to this investigation, however, IR was generated to address the immediate concern.	A8931RP	As established by IR# 468004

Other Issues identified during investigation	Corrective Action (CA) or Action Item (ACIT)	Owner	Due Date
PORC Meeting minutes are not a stand-alone document.	IR# 468002 generated for Regulatory Assurance to evaluate the practice of documenting PORC meeting minutes and how open actions/questions are addressed and track via CAP.	A8901RA	As established by IR# 468002
Berm at acid unloading station is not secured to ground	IR# 468836 generated for this condition. While reviewing extent of condition, the acid unloading station at the Lake Screen House was walked down. This berm is not attached to the ground is susceptible to the same failure mode as the berm located at FRAC Tank Farm#1 and #2.	A8910OPS	As established by IR# 468836
Multiple tritium (H_3) samples above Lower Limit of Detection (LLD) with no issue reports generated	IR# 468626 generated for this condition. While review data for this investigation, it was identified that ~~20~~ multiple berm area tritium samples were above LLD with no IRs generated to identify or disposition this condition.	A8931RP	As established by IR# 468626
Chemistry Sample Data Record Retention Issue	When reviewing data for the FRAC farm berm leak it was identified the corrective action in the work group evaluation (IR# 292053) and in the CA (292053-02) have not corrected the ability to retrieve all records concerning chemistry sample data.	A8932CHEM	As established by IR# 468960

Other Issues identified during investigation	Corrective Action (CA) or Action Item (ACIT)	Owner	Due Date
FRAC Tank Farm #2 berm and water issues	NRC inspectors found that the installation of the FRAC Tank Farm #2 berm installed in the SGRP had collapsed on the backside of the four tanks installed. Additionally, standing water was found in the berm area. Actions were taken to remediate the berm installation, sample and remove the standing water in the berm and correct the source of the leakage (hoses).	A8940PGMT	As established by IR# 466356
FRAC Tank water transfer hose and berm concerns	Concerns were raised by NOS concerning roping off the area around FRAC Tank Farm #2 and that the signage installed at FRAC Tank Farm #1 not being predominately visible. Additional concerns were raised about the transfer hose from FRAC Tank Farm #1 to FRAC Tank Farm #2 being pinched as it enters the window to the SGRP building and a bucket placed under the transfer hose fittings with water in the bucket. Corrective actions were taken to install a fitting free hose, removal of the bucket and improving signage at the two FRAC Tank Farms	A8922MM	As established by IR# 466812

Other Issues identified during investigation	Corrective Action (CA) or Action Item (ACIT)	Owner	Due Date
FRAC Tank Walkdown Issues	Ops performed a walkdown of the FRAC Tank Farm installations at the M&O pad and the SGRP building. Numerous issues were identified including the bagging of hose fittings, standing water in the berm areas, electrical cables in contact with the berm walls. Per the IR closure comments, all required actions to resolve the identified problems have been completed.	A8922MM	As established by IR# 467150
BwCP 220-2 Procedure Step Not Performed	While performing interviews with chemistry personnel, it was identified that step F.3.j of BwCP 220-2 was N/A'd during analysis of tritium samples. This is contrary to HU-AA-101 OOPS, step 4.3 and HU-AA-104-101 steps 4.1.1, 4.1.7 and 4.5.2.	A8932CHEM	As established by IR# 469975
No Standard Unit Of Measure Is Used For Tritium Samples	During RCR investigation (IR# 465719), it was determined that the Chemistry sample results are documented in micro Curies per Gram (uCi/gm) where as tritium results are reported in pico Curies per Liter (pCi/L). These unit difference causes confusion when discussing sample results.	A8932CHEM	As established by IR# 00469997

Other Issues identified during investigation	Corrective Action (CA) or Action Item (ACIT)	Owner	Due Date
Problems identified with ALPS ability to produce good water	During testing of the ALPS 2 modification, difficulties have been encountered in producing reactor grade water for storage in the PWST. Problems have been identified with total organic concentrations (TOC) and the removal of boron from the output of the ALPS 2 modification. If the ALPS cannot be made functional, on site storage of release water will have to be stored in the FRAC tanks.	A8940PGMT	As established by IR# 470194
BwCP 200-2T1 tritium sample data sheet(s) missing/unsigned	The investigation team could not locate the BwCP 220-2T1 Tritium Sample Data Sheet from 1/18/06. The chemistry log identifies that a RP technician signed for removing the sheet from the chemistry office area. Additionally, four data sheets were identified as not containing the "reviewed by" signature (sheets dated 1/30/06, 2/2/06, 3/7/06, 3/10/06, 3/14/06) when copies were made for the investigation team. Potentially these sheets were not reviewed in a timely manner.	A8932CHEM	As established by IR# 470329

Communications Plan:

Lessons Learned to be Communicated	Communication Plan Action	Owner	Due Date
Root cause investigation results	Nuclear Event Response (NER)	A8910OP	~~3/31/06~~4/4/06
Root cause investigation results	Nuclear Network Operational Experience (NNOE)	A8901OPEX	~~4/4/06~~4/7/06

Lessons Learned to be Communicated	Communication Plan Action	Owner	Due Date
Event description, cause and corrective actions	Station Alignment presentation: Ensure presentation includes ownership responsibilities in addition to the event details.	A8910OP	4/4/06
Causal Factor #4 IR# 443611 remained in SOC for over 8 days. IR# 443611 identified a potential safety concern that SOC failed to address in a timely manner.	Review IR# 443611 with SOC in regard to timely action to address potential safety concerns.	A8901RA	7/14/06

Root Cause Report Quality Checklist
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A. Critical Content Attributes	YES	NO
1. Is the condition that requires resolution adequately and accurately identified?	X	
2. Are inappropriate actions and equipment failures (causal factors) identified?	X	
3. Are the causes accurately identified, including root causes and contributing causes?	X	
4. Are there corrective actions to prevent recurrence identified for each root cause and do they tie DIRECTLY to the root cause? AND, are there corrective actions for contributing cause and do they tie DIRECTLY to the contributing cause?	X	
5. Have the root cause analysis techniques been appropriately used and documented?	X	
6. Was an Event and Causal Factors Chart properly prepared?	X	
7. Does the report adequately and accurately address the extent of condition in accordance with the guidance provided in Attachment 3 of LS-AA-125-1003, Reference 4.3?	X	
8. Does the report adequately and accurately address plant specific risk consequences?	X	
9. Does the report adequately and accurately address programmatic and organizational issues?	X	
10. Have previous similar events been evaluated? Has an Operating Experience database search been performed to determine whether the problem was preventable if industry experience had been adequately implemented?	X	
B. Important Content Attributes		
1. Are all of the important facts included in the report?	X	
2. Does the report explain the logic used to arrive at the conclusions?	X	
3. If appropriate, does the report explain what root causes were considered, but eliminated from further consideration and the bases for their elimination from consideration?	X	
4. Does the report identify contributing causes, if applicable?	X	
5. Is it clear what conditions the corrective actions are intended to create?	X	
6. Are there unnecessary corrective actions that do not address the root causes or contributing causes?		X
7. Is the timing for completion of each corrective action commensurate with the importance or risk associated with the issue?	X	

Root Cause Report Quality Checklist
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C. Miscellaneous Items	YES	NO
1. Did an individual who is qualified in Root Cause Analysis prepare the report?	X	
2. Does the Executive Summary adequately and accurately describe the significance of the event, the event sequence, root causes, corrective actions, reportability, and previous events?	X	
3. Do the corrective actions include an effectiveness review for corrective actions to prevent recurrence?	X	
4. Were **ALL** corrective actions entered and verified to be in Action Tracking?	X*	
5. Are the format, composition, and rhetoric acceptable (grammar, typographical errors, spelling, acronyms, etc.)?	X	

* Assignments in support of investigation completion have been created in Passport and also include the NER and NNOE assignments. All other assignments requested as a result of this investigation will be entered into Passport upon review and approval of this investigation.

Root Cause Report Attachment Table of Contents

Root Cause Investigation Charter
Attachment 1

IR Number:
465719

Sponsoring Manager:
Gary Dudek - Operations Director

Qualified Root Cause Investigator(s):
Jim Grzemski - Engineering
Eric Johnston - Maintenance
Barry Tumblin - Operations

Team Investigator(s):
Laurie Antos - Security
Rick Gayheart - Training
Rick Leasure - Radiation Protection
Mike Spisak - Materials Management
Roxanna Taylor - Maintenance
Donna Turner - Business Operations
Chemistry Department – **Representative To Be Determined**

Scope:
The stations failure to recognize and respond to unacceptable conditions with respect to temporary tritium storage in a timely fashion resulting in release of tritiated water outside the intended control area.

The Root Cause Investigation Team (RCIT) has determined the following three focus areas for the investigation:

Design:
- Design change
  - PORC approval of design change
- Design installation and implementation
  - Design details regarding berm installation
  - Design details regarding running of hose

Issues Addressed:
- Review and screening of issue reports
- Evaluate the Shift Response, Station Ownership Committee (SOC), and/or Management Review Committee (MRC) actions on issues

Operation of FRAC Farm:
- Transfer of water, including procedures and set-up of the conditions/equipment for transfers.
- Hose movement, including work package documentation.
- Sampling of berm area water, including procedures governing these activities and reporting thresholds.
- Berm water control, including addressing standing water.
- When the new system was implemented, what was done to promote appropriate sampling regime, periodic walk downs – with criteria, and to establish standards for activity and / or water level in berm.
- What process, if applicable, directs such standards and protocols and to what extent was the standard followed
- How was the site prepared to deal with the heightened sensitivity

Investigation of the above areas will be performed by use of interviews with pertinent personnel, review of Engineering Change, PORC Meeting minutes, work packages, and applicable procedures. A technical human performance brief of the RCIT members was held on 3/15/2006 in accordance with HU-AA-1212.

Interim Corrective Actions:

Corrective Actions Implemented during the Prompt Investigation:

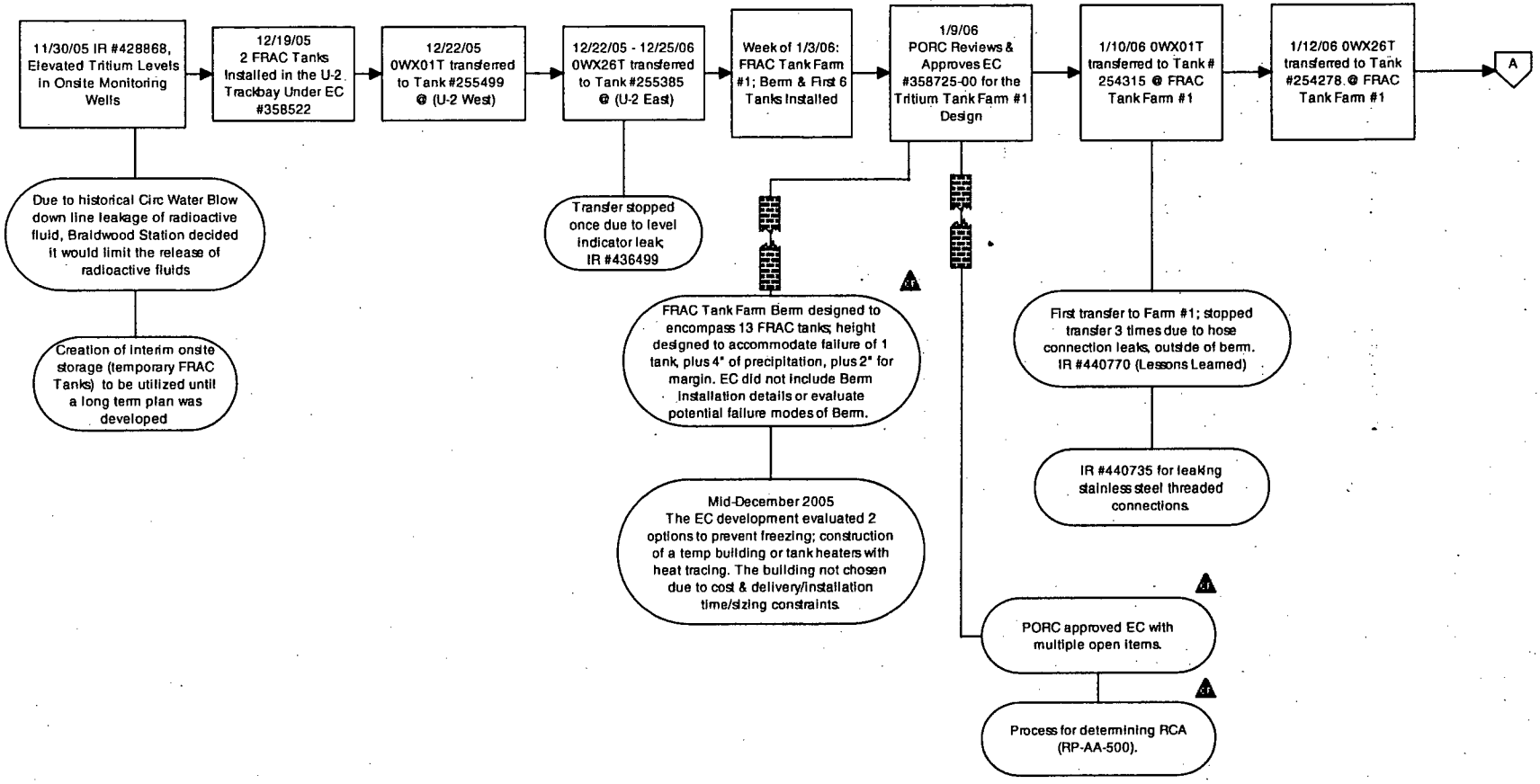
- MMD performed maintenance to the berm walls, ensuring that the berm walls are more robust. These actions included securing the berm walls with screws, to prevent the berm walls from collapsing.
- Samples were pulled within a 300' radius if the Number 1 FRAC Tank Farm.
- Water was pumped from the ground puddles to the berm area, and then returned to the FRAC Tank.
- Tritium team to recommend actions to the troubleshooting plan and communicate those changes to station personnel.
- Operations Department to perform walkdowns of the two berm areas every 4 hours, and report any deviations to Radiation Protection.
- Engineering to address possible enhancements to the berm structures that would increase the berm robustness.
- Keep the berm area free of water with the exception of active precipitation.
- Perform a thorough walkdown of the material condition of the FRAC tank temporary equipment.

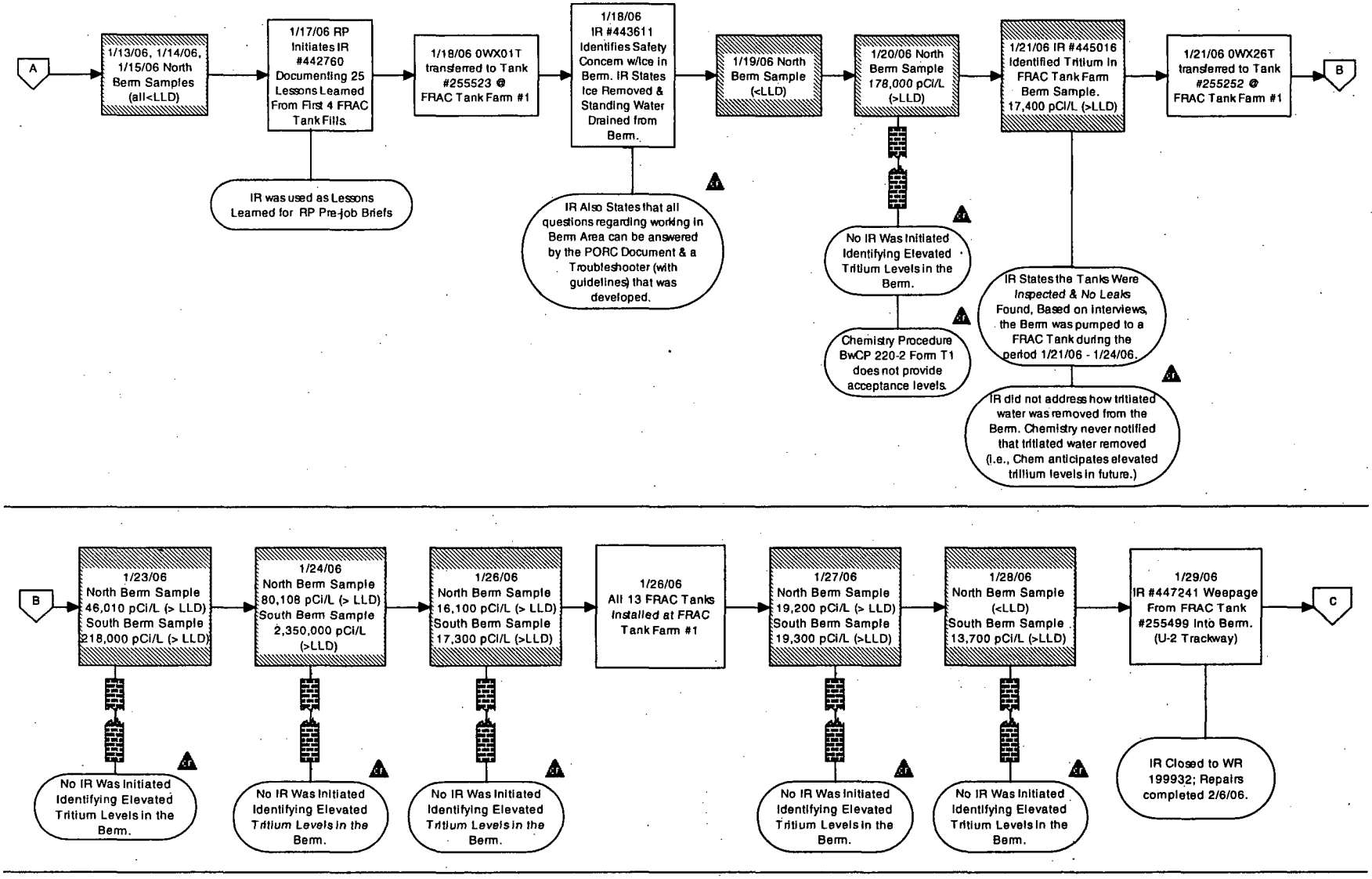
Root Cause Report Milestones:

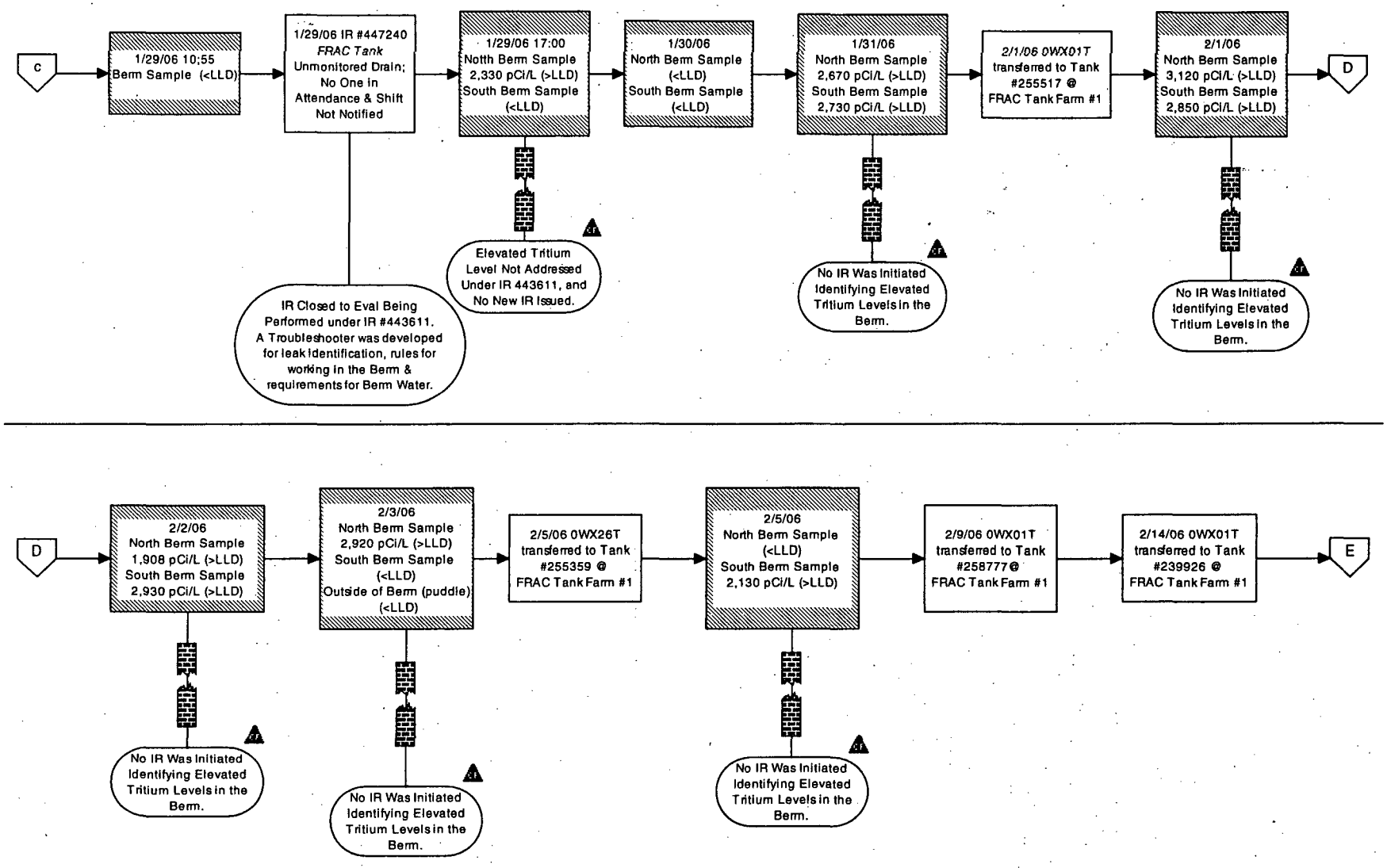
1.	Event Date	(3/13/2006)
2.	Screening Date	(3/14/2006)
3.	Completion of Charter	(3/15/2006)
4.	Status Briefing for Charter	(3/16/2006)
5.	Two Week Update	(Not Applicable)
6.	Sponsoring Manager Report Approval	(3/21/2006)
7.	Review by MRC	(3/22/2006)
8.	Final Root Cause Investigation Due Date	(3/22/2006)

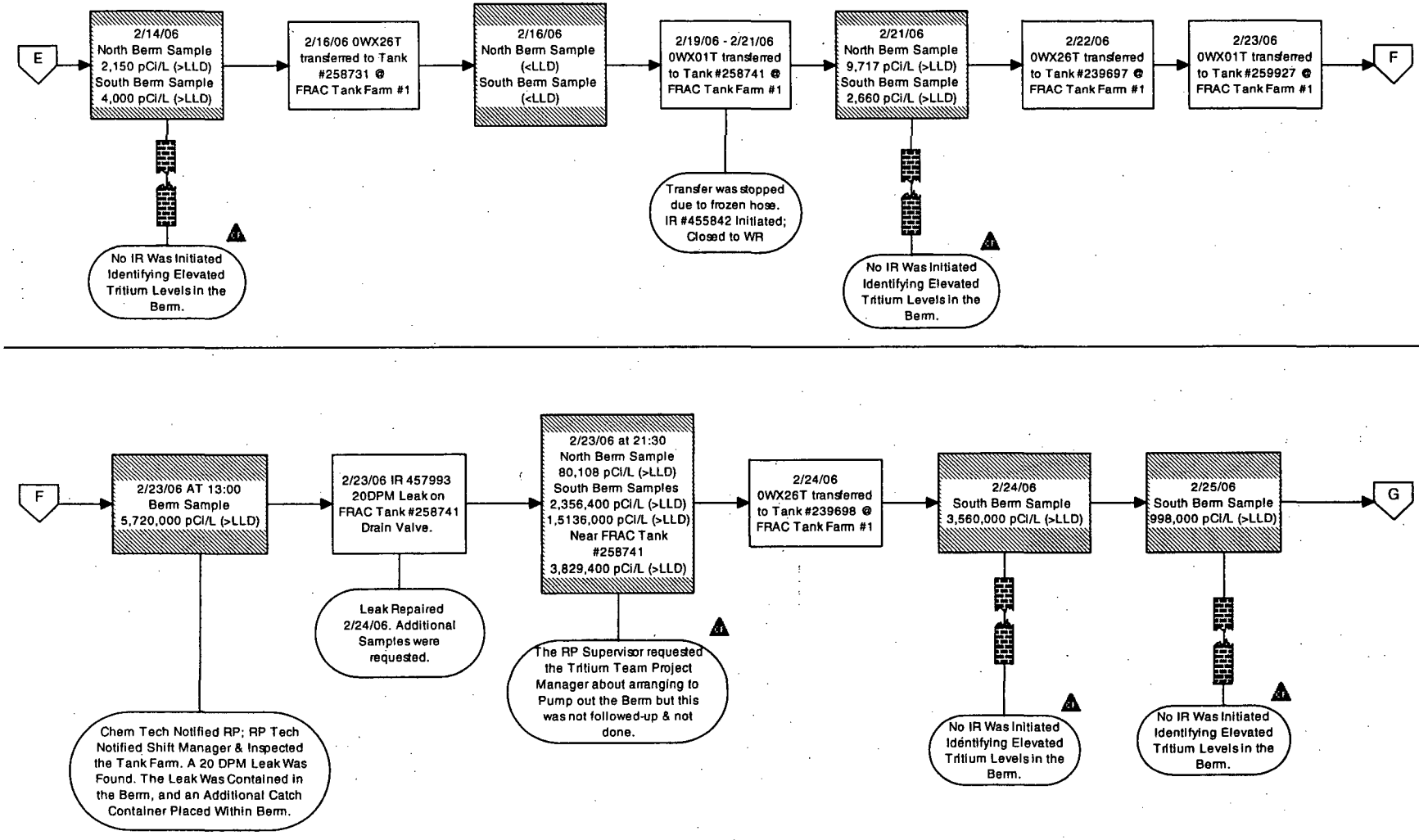
Event and Causal Factor Chart
Attachment 2

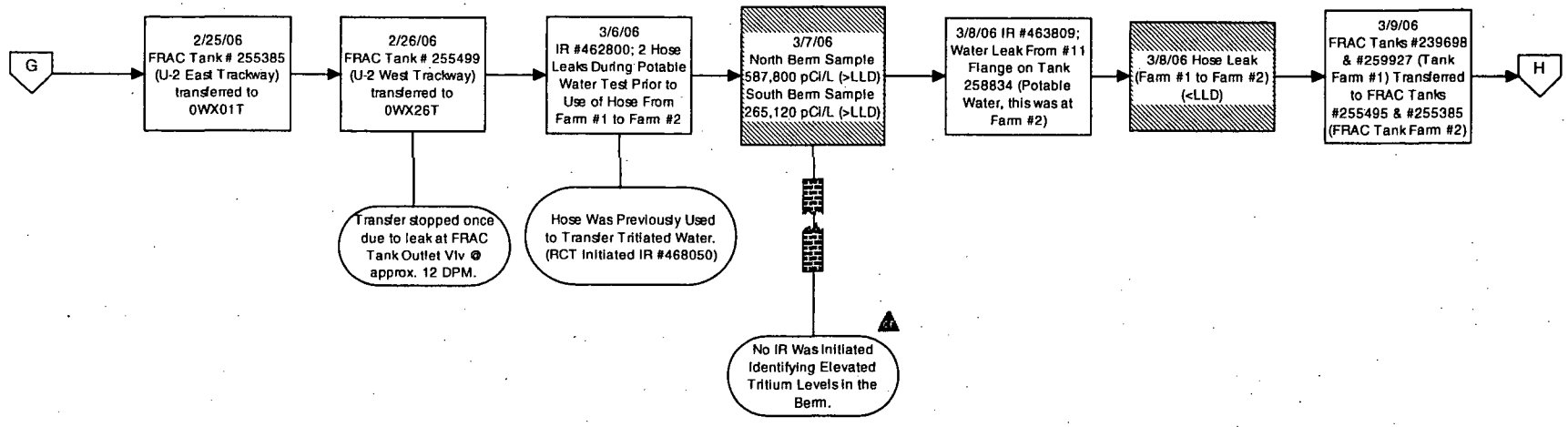
NOTE: The ECF chart consists of 10 interconnected sections.

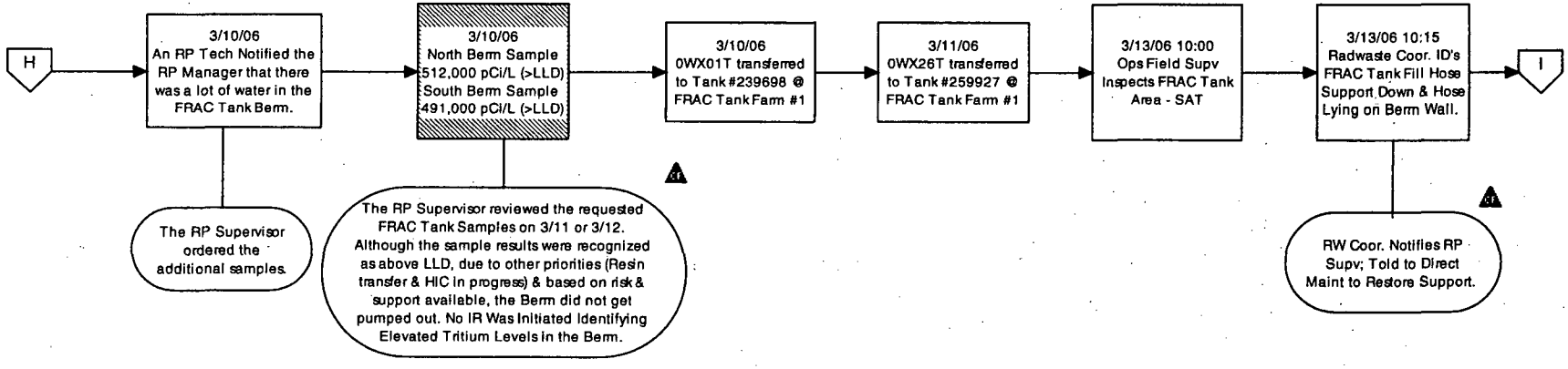


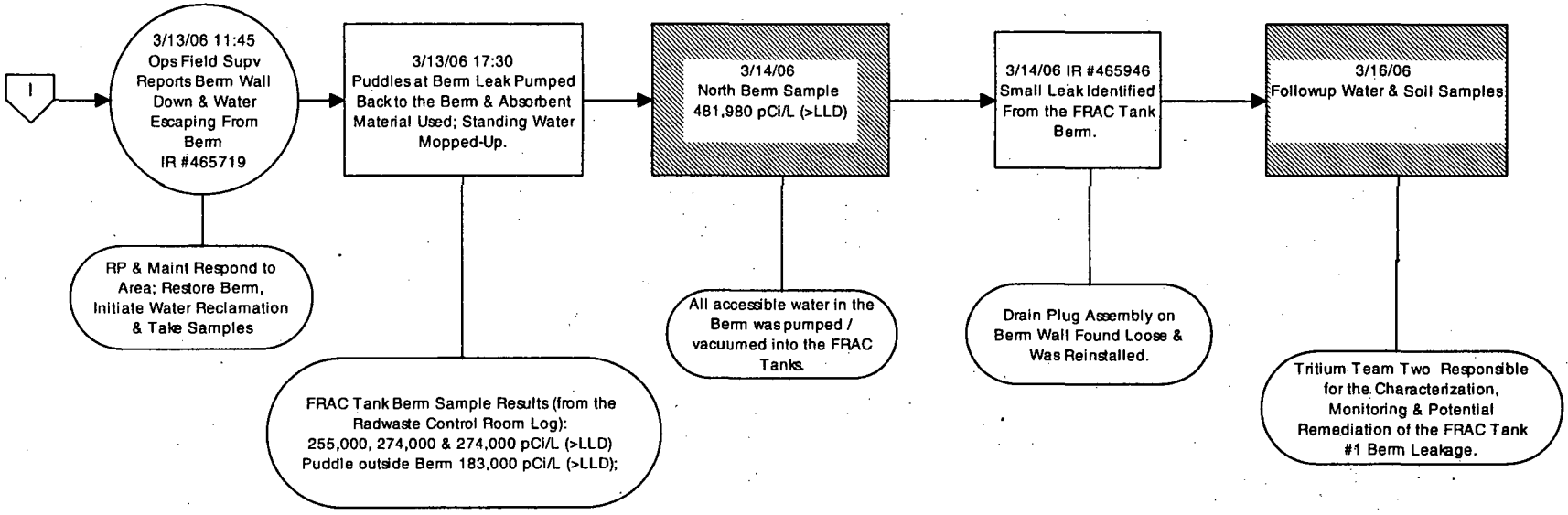

A
1/13/06, 1/14/06, 1/15/06 North Berm Samples (all<LLD)
1/17/06 RP Initiates IR #442760 Documenting 25 Lessons Learned From First 4 FRAC Tank Fills.
IR was used as Lessons Learned for RP Pre-job Briefs
1/18/06 0WX01T transferred to Tank #255523 @ FRAC Tank Farm #1
1/18/06 IR #443611 Identifies Safety Concern w/Ice in Berm. IR States Ice Removed & Standing Water Drained from Berm.
IR Also States that all questions regarding working in Berm Area can be answered by the PORC Document & a Troubleshooter (with guidelines) that was developed.
1/19/06 North Berm Sample (<LLD)
1/20/06 North Berm Sample 178,000 pCi/L (>LLD)
No IR Was Initiated Identifying Elevated Tritium Levels in the Berm.
Chemistry Procedure BwCP 220-2 Form T1 does not provide acceptance levels.
1/21/06 IR #445016 Identified Tritium In FRAC Tank Farm Berm Sample. 17,400 pCi/L (>LLD)
IR States the Tanks Were Inspected & No Leaks Found, Based on Interviews, the Berm was pumped to a FRAC Tank during the period 1/21/06 - 1/24/06.
IR did not address how tritiated water was removed from the Berm. Chemistry never notified that tritiated water removed (i.e., Chem anticipates elevated trillium levels in future.)
1/21/06 0WX26T transferred to Tank #255252 @ FRAC Tank Farm #1
B
B
1/23/06 North Berm Sample 46,010 pCi/L (> LLD) South Berm Sample 218,000 pCi/L (> LLD)
No IR Was Initiated Identifying Elevated Tritium Levels in the Berm.
1/24/06 North Berm Sample 80,108 pCi/L (> LLD) South Berm Sample 2,350,000 pCi/L (>LLD)
No IR Was Initiated Identifying Elevated Tritium Levels in the Berm.
1/26/06 North Berm Sample 16,100 pCi/L (> LLD) South Berm Sample 17,300 pCi/L (>LLD)
No IR Was Initiated Identifying Elevated Tritium Levels in the Berm.
1/26/06 All 13 FRAC Tanks Installed at FRAC Tank Farm #1
1/27/06 North Berm Sample 19,200 pCi/L (> LLD) South Berm Sample 19,300 pCi/L (>LLD)
No IR Was Initiated Identifying Elevated Tritium Levels in the Berm.
1/28/06 North Berm Sample (<LLD) South Berm Sample 13,700 pCi/L (>LLD)
No IR Was Initiated Identifying Elevated Tritium Levels in the Berm.
1/29/06 IR #447241 Weepage From FRAC Tank #255499 Into Berm. (U-2 Trackway)
IR Closed to WR 199932; Repairs completed 2/6/06.
C


C
1/29/06 10;55 Berm Sample (<LLD)
1/29/06 IR #447240 FRAC Tank Unmonitored Drain; No One in Attendance & Shift Not Notified
1/29/06 17:00 Notth Berm Sample 2,330 pCi/L (>LLD) South Berm Sample (<LLD)
1/30/06 North Berm Sample (<LLD) South Berm Sample (<LLD)
1/31/06 North Berm Sample 2,670 pCi/L (>LLD) South Berm Sample 2,730 pCi/L (>LLD)
2/1/06 0WX01T transferred to Tank #255517 @ FRAC Tank Farm #1
2/1/06 North Berm Sample 3,120 pCi/L (>LLD) South Berm Sample 2,850 pCi/L (>LLD)
D
IR Closed to Eval Being Performed under IR #443611. A Troubleshooter was developed for leak identification, rules for working in the Berm & requirements for Berm Water.
Elevated Tritium Level Not Addressed Under IR 443611, and No New IR Issued.
No IR Was Initiated Identifying Elevated Tritium Levels in the Berm.
No IR Was Initiated Identifying Elevated Tritium Levels in the Berm.
D
2/2/06 North Berm Sample 1,908 pCi/L (>LLD) South Berm Sample 2,930 pCi/L (>LLD)
2/3/06 North Berm Sample 2,920 pCi/L (>LLD) South Berm Sample (<LLD) Outside of Berm (puddle) (<LLD)
2/5/06 0WX26T transferred to Tank #255359 @ FRAC Tank Farm #1
2/5/06 North Berm Sample (<LLD) South Berm Sample 2,130 pCi/L (>LLD)
2/9/06 0WX01T transferred to Tank #258777@ FRAC Tank Farm #1
2/14/06 0WX01T transferred to Tank #239926 @ FRAC Tank Farm #1
E
No IR Was Initiated Identifying Elevated Tritium Levels in the Berm.
No IR Was Initiated Identifying Elevated Tritium Levels in the Berm.
No IR Was Initiated Identifying Elevated Tritium Levels in the Berm.


E
2/14/06
North Berm Sample
2,150 pCi/L (>LLD)
South Berm Sample
4,000 pCi/L (>LLD)
No IR Was Initiated Identifying Elevated Tritium Levels in the Berm.
2/16/06 0WX26T transferred to Tank #258731 @ FRAC Tank Farm #1
2/16/06
North Berm Sample
(<LLD)
South Berm Sample
(<LLD)
2/19/06 - 2/21/06
0WX01T transferred to Tank #258741 @ FRAC Tank Farm #1
Transfer was stopped due to frozen hose. IR #455842 Initiated; Closed to WR
2/21/06
North Berm Sample
9,717 pCi/L (>LLD)
South Berm Sample
2,660 pCi/L (>LLD)
No IR Was Initiated Identifying Elevated Tritium Levels in the Berm.
2/22/06
0WX26T transferred to Tank #239697 @ FRAC Tank Farm #1
2/23/06
0WX01T transferred to Tank #259927 @ FRAC Tank Farm #1
F
F
2/23/06 AT 13:00
Berm Sample
5,720,000 pCi/L (>LLD)
Chem Tech Notified RP; RP Tech Notified Shift Manager & Inspected the Tank Farm. A 20 DPM Leak Was Found. The Leak Was Contained in the Berm, and an Additional Catch Container Placed Within Berm.
2/23/06 IR 457993
20DPM Leak on FRAC Tank #258741 Drain Valve.
Leak Repaired 2/24/06. Additional Samples were requested.
2/23/06 at 21:30
North Berm Sample
80,108 pCi/L (>LLD)
South Berm Samples
2,356,400 pCi/L (>LLD)
1,5136,000 pCi/L (>LLD)
Near FRAC Tank #258741
3,829,400 pCi/L (>LLD)
The RP Supervisor requested the Tritium Team Project Manager about arranging to Pump out the Berm but this was not followed-up & not done.
2/24/06
0WX26T transferred to Tank #239698 @ FRAC Tank Farm #1
2/24/06
South Berm Sample
3,560,000 pCi/L (>LLD)
No IR Was Initiated Identifying Elevated Tritium Levels in the Berm.
2/25/06
South Berm Sample
998,000 pCi/L (>LLD)
No IR Was Initiated Identifying Elevated Tritium Levels in the Berm.
G


G
2/25/06
FRAC Tank # 255385 (U-2 East Trackway) transferred to 0WX01T
2/26/06
FRAC Tank # 255499 (U-2 West Trackway) transferred to 0WX26T
Transfer stopped once due to leak at FRAC Tank Outlet Vlv @ approx. 12 DPM.
3/6/06
IR #462800; 2 Hose Leaks During Potable Water Test Prior to Use of Hose From Farm #1 to Farm #2
Hose Was Previously Used to Transfer Tritiated Water. (RCT Initiated IR #468050)
3/7/06
North Berm Sample 587,800 pCi/L (>LLD) South Berm Sample 265,120 pCi/L (>LLD)
No IR Was Initiated Identifying Elevated Tritium Levels in the Berm.
3/8/06 IR #463809; Water Leak From #11 Flange on Tank 258834 (Potable Water, this was at Farm #2)
3/8/06 Hose Leak (Farm #1 to Farm #2) (<LLD)
3/9/06
FRAC Tanks #239698 & #259927 (Tank Farm #1) Transferred to FRAC Tanks #255495 & #255385 (FRAC Tank Farm #2)
H


H
3/10/06
An RP Tech Notified the RP Manager that there was a lot of water in the FRAC Tank Berm.
The RP Supervisor ordered the additional samples.
3/10/06
North Berm Sample 512,000 pCi/L (>LLD) South Berm Sample 491,000 pCi/L (>LLD)
The RP Supervisor reviewed the requested FRAC Tank Samples on 3/11 or 3/12. Although the sample results were recognized as above LLD, due to other priorities (Resin transfer & HIC in progress) & based on risk & support available, the Berm did not get pumped out. No IR Was Initiated Identifying Elevated Tritium Levels in the Berm.
3/10/06
0WX01T transferred to Tank #239698 @ FRAC Tank Farm #1
3/11/06
0WX26T transferred to Tank #259927 @ FRAC Tank Farm #1
3/13/06 10:00
Ops Field Supv Inspects FRAC Tank Area - SAT
3/13/06 10:15
Radwaste Coor. ID's FRAC Tank Fill Hose Support Down & Hose Lying on Berm Wall.
RW Coor. Notifies RP Supv; Told to Direct Maint to Restore Support.
I



~~INSERT CHART HERE~~

FRAC Tank Area Photos - Attachment 3

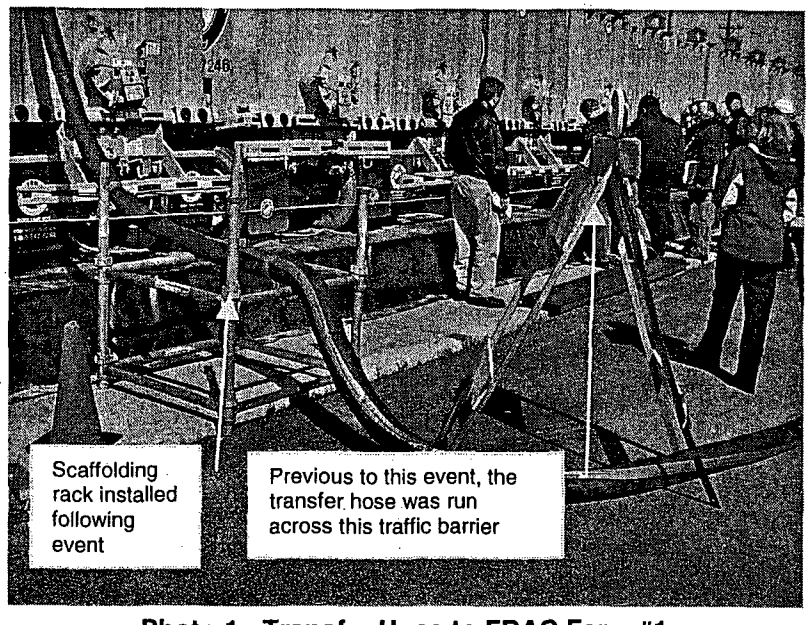


Photo 1 - Transfer Hose to FRAC Farm #1

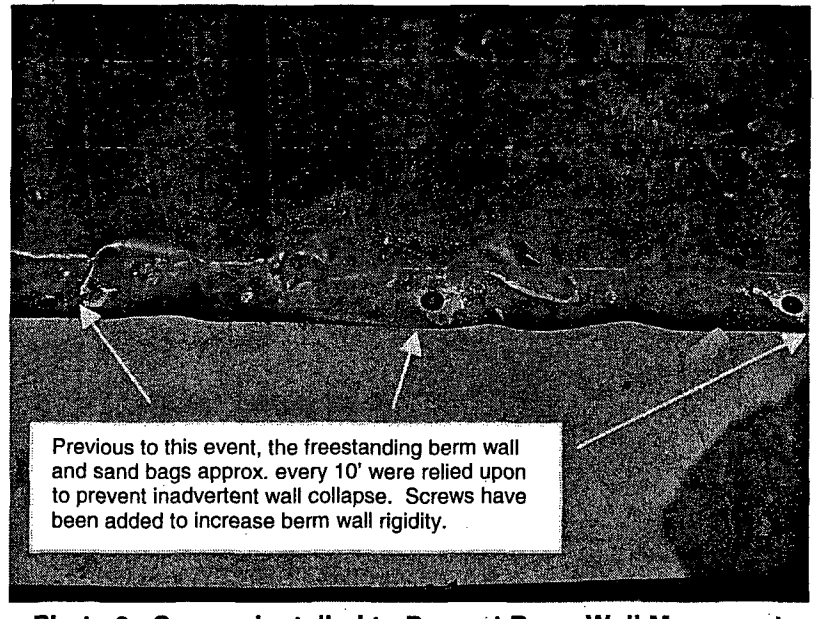


Photo 2 - Screws installed to Prevent Berm Wall Movement

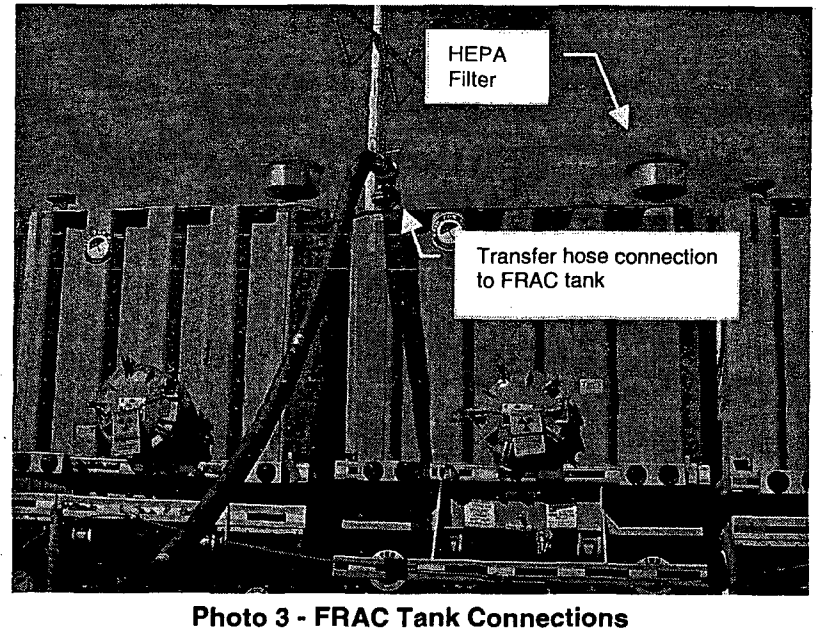


Photo 3 - FRAC Tank Connections

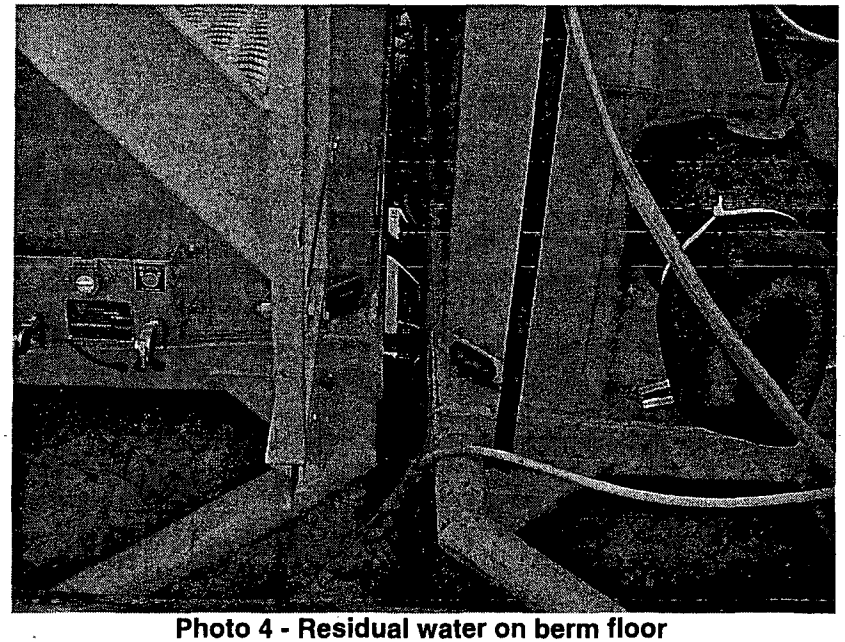


Photo 4 - Residual water on berm floor

Tritiated Water Transfer Equipment / FRAC Tank Farm Walk-down Criteria Attachment 4

4 hour walkdowns on outside tanks/equipment and 12 hour walkdowns on inside Tanks/equipment or as directed by SDO

NOTE
Some water may exist between the FRAC Tanks due to difficulty of getting equipment positioned to vacuum / pump it out. No accessible water is acceptable.

- No standing water within the berm.
  - During rain / snow conditions, notify RP to implement appropriate sampling regime
- Inspect hoses and mechanical joints for evidence of leakage. No leakage is acceptable.
- No obstructions or impacts to the integrity of the berm or equipment.
  - No equipment draped over berm wall unless properly supported and not touching the berm wall.
- Ensure all hose connections are bagged.
- Verify the Heat Trace system is operational.
- No leaks on temporary Turbine Building piping and hoses
- Equipment not disturbed since last walk-down (when same person).
- For ANY deviation from this criteria:
  - Follow Communications Protocol
  - Initiate IR to document discrepancy
- During windy conditions, Shift Manager to determine need for increased frequency of tours.

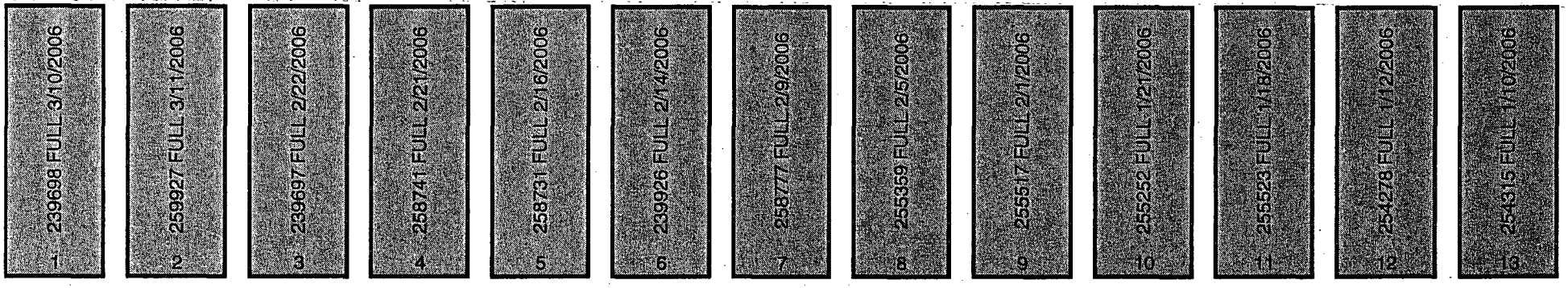
Communications Protocol

- Notify Shift Manager
  - Shift Manager to Notify Station Duty Officer (SDO)
  - Station Duty Officer to notify Duty Station Manager
  - Shift Manager to place issue on POD "Immediate Attention" section until issue is resolved.
  - Duty Station Manager to Notify:
    - Plant Manager
    - Site Vice President
    - Radiation Protection Manager
  - Duty Station Manager to assemble duty team to develop action plan for prompt issue resolution.

This guidance has been issued as Braidwood Policy Memo BR-060.

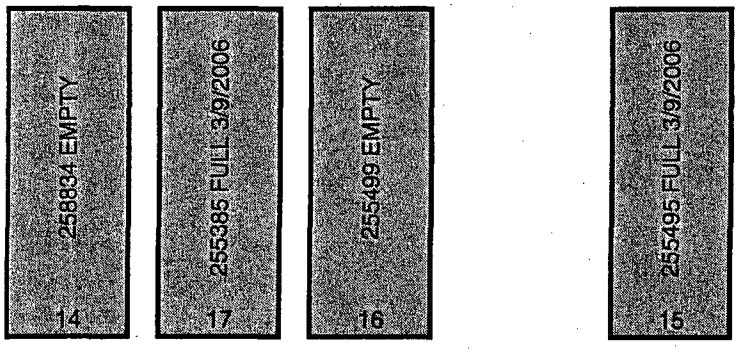
FRAC Tank Layouts
Attachment 5

M&O FRAC Tank Pad Layout (FRAC Farm #1)



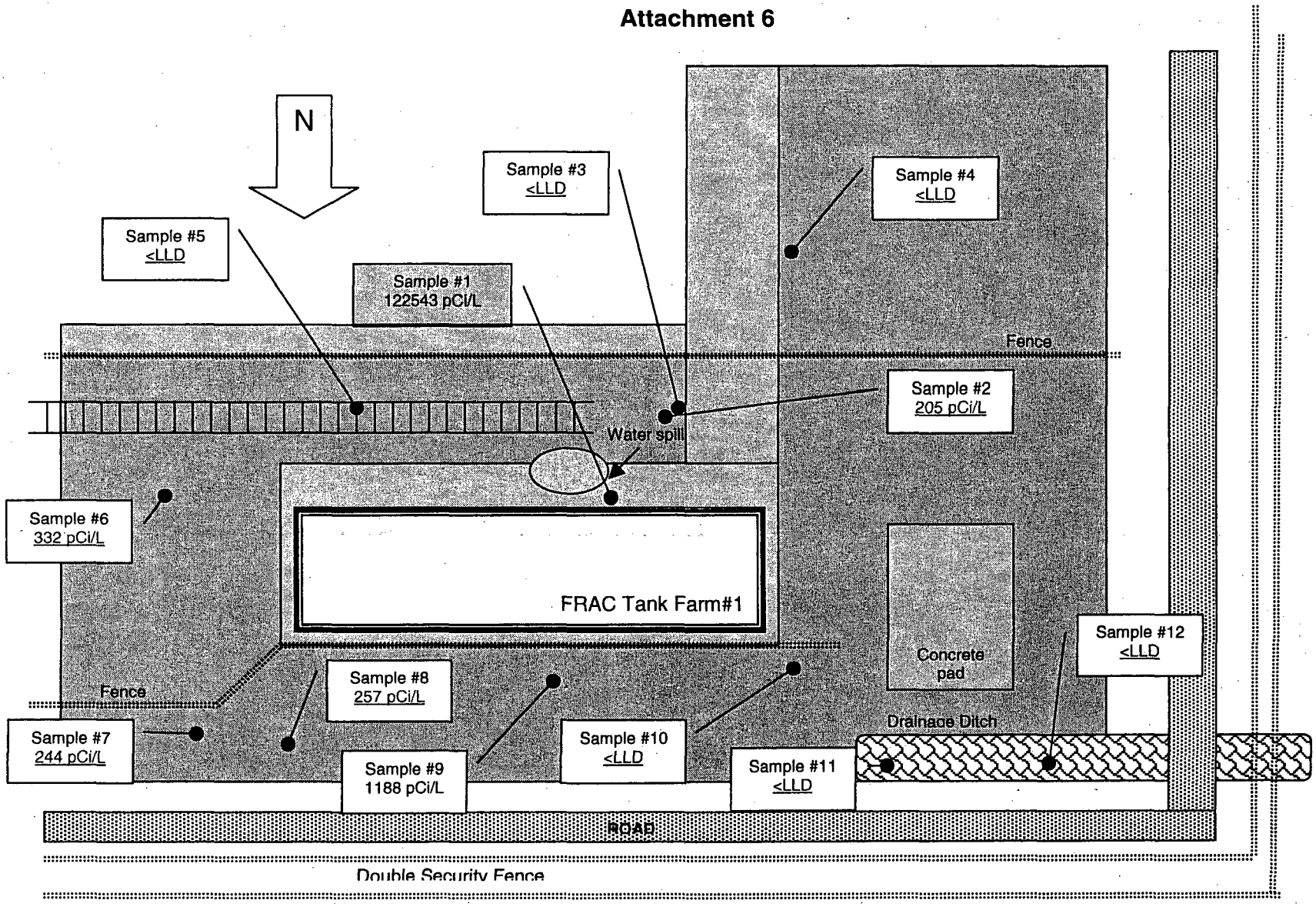
Number on bottom is tank number is per EC. Number on top is the tank number from the drivers side front corner of the tank.
BwOP 501T4 and 526T4 require the number from the tank.

SG Building FRAC Tank Layout (FRAC Farm #2)



FRAC Tank Farm #1 Sample Results from March 13, 2006 Soil/Water Samples

Attachment 6



Date/Time of Sample	Sample Location	Sample Results (pCi/L)	Precipitation
01/13/06 @ 1120	Berm	1670	0.67
01/14/06 @ 0750	Berm	1670	0.00
01/15/06 @ 0750	Berm	1670	0.00
1/18/06	**Berm snow and ice shoveled**		
01/19/06 @ 0825	Berm	1670	0.00
01/20/06 @ 0745	Berm	178000	0.78
01/21/06 @ 0740	Berm Sample outside	15080	0.04
01/21/06 @ 0740	Berm outside sample	17400	
01/21/06	**Berm transferred to FRAC Tank**		
01/21/06 @ 1545	Berm	9717	
01/23/06 @ 1105	Berm next to Frac #255252	218000	0.00
01/23/06 @ 1115	Berm NW Corner	46010	
01/23/06 @ 1120	Berm SW Corner	1670	
01/26/06 @ 0735	S Berm Frac tanks	16100	0.00
01/26/06 @ 0740	NE Berm Frac tank	17300	
01/27/06 @ 0745	S Berm Sample	19200	0.00
01/27/06 @ 0750	N Berm Sample	19300	
01/28/06 @ 0735	S Berm	1670	0.48
01/28/06 @ 0730	NE Berm side of Frac tank	13750	
01/29/06 @ 0815	South Berm	1670	0.27
01/29/06 @ 0820	NE Berm	1670	
01/29/06	**Berm plug removed and berm drained to ground**		
01/29/06 @ 1900	Frac tank berm	2330	
01/30/06 @ 0905	NE Corner	1670	0.00
01/30/06 @ 0930	SW Corner	1670	
01/31/06 @ 0745	S Berm	2730	0.00
01/31/06 @ 0750	NE Corner	2670	

Date/Time of Sample	Sample Location	Sample Results (pCi/L)	Precipitation
02/01/06 @ 1115	S Berm	3120	0.00
02/01/06 @ 1120	NE Corner	2850	
02/02/06 @ 0855	S Berm	2973	0.01
02/02/06 @ 0900	NE Corner	1908	
02/03/06 @ 0815	S Berm	1670	0.04
02/03/06 @ 0820	NE Corner	2920	
02/05/06 @ 0800	SW Berm	1670	0.00
02/05/06 @ 0800	NE Berm	2130	
02/14/06 @ 1103	S Berm	2153	0.00
02/14/06 @ 1110	W Berm	4000	
02/16/06 @ 1042	N Berm	1670	0.40
02/16/06 @ 1113	S Berm	1670	
02/21/06 @ 1338	S Berm	2660	0.00
02/23/06 @ 1300	Berm	5720000	0.00
02/23/06 @ 2140	SE Corner	1513600	
02/23/06 @ 2130	SW Corner	2356400	
02/23/06 @ 2130	NW Corner	80108	
02/23/06 @ 2130	Near #258741	3829400	
02/24/06 @ 1425	S Berm	1150000	0.00
02/24/06 @ 1417	SW Berm	3560000	
02/25/06 @ 1355	S Berm	998000	0.00
03/07/06 @ 1712	Near #259927	587800	0.00
03/07/06 @ 1715	Near #259927	265120	
03/10/06 @ 1725	S of #258777	491000	0.00
03/10/06 @ 1725	N of #258777	512000	
03/14/06 @ 1610	NW Corner	481980	0.01
03/14/06 @ 1705	NW	1670	