

Shell Pipe Line Corp.

1939 Pipeline

Explosion

McCamey - Cushing 10"

NAME

L. W. Garrison

"PIPELINE EXPLOSION --  
BACK IN THE 'NOT-SO' GOOD OLD DAYS"

ON DECEMBER 12, 1939, A SECTION OF 26.8 MILES OF 10" CRUDE OIL PIPELINE WAS LITERALLY BLOWN OUT OF THE GROUND IN EIGHT MINUTES TIME WITH EXPLOSIONS OR DETONATIONS RUNNING UP TO 60 TO 70 PER MILE. THIS SECTION OF LINE IS IN SHELL PIPE LINE CORPORATION'S McCAMEY, TEXAS - CUSHING OKLAHOMA 10". A PART OF THE SYSTEM THAT FURNISHED CRUDE OIL TO SHELL'S WOOD RIVER, ILLINOIS AND EAST CHICAGO, INDIANA REFINERIES. SPECIFICALLY, THE DAMAGED SECTION WAS BETWEEN ARCHER STATION IN TEXAS AND RYAN STATION IN OKLAHOMA.

→ (SHOW SLIDE #1 - DIAGRAM OF LINE)  
→ (EXPLAIN THIS DIAGRAM)

AT THE TIME OF THE EXPLOSIONS, COMPRESSED AIR WAS BEING USED TO PUSH SCRAPERS TO DISPLACE THE CRUDE OIL IN THE PIPELINE. THIS PRACTICE, WITH SOME VARIATIONS, HAD BEEN USED BY OTHER ORGANIZATIONS IN THE INDUSTRY.

IMMEDIATELY AFTER THE DISASTER, AN INVESTIGATING COMMITTEE WAS APPOINTED AND SENT TO THE SCENE TO MAKE A COMPLETE INVESTIGATION. THE FACTS AND CONCLUSIONS PRESENTED HERE TODAY ARE, FOR THE MOST PART, THOSE OF THIS COMMITTEE AS TAKEN FROM THEIR OFFICIAL REPORT.

## REASONS FOR OIL DISPLACEMENT

THE REASON FOR DISPLACEMENT OF THE OIL WITH AIR WAS TO FIND AND REPAIR EXTERNAL CORROSION LEAKS IN THE PIPELINE. THE SOIL WAS EXTREMELY DRY AND LEAKS IN THE LINE HAD BEEN DIFFICULT TO LOCATE. THE OIL LOSS WAS SIGNIFICANT. ON MANY OCCASIONS THE OIL WOULD DISAPPEAR INTO THE DRY GROUND WITHOUT EVIDENCE OF A LEAK ON THE SURFACE. THE DECISION TO USE AIR TO DISPLACE THE OIL AND TO TEST THE LINE FOR LEAKS WAS BASED UPON: (1) THE FAILURE OF LOCATING ALL THE LEAKS BY OTHER STANDARD METHODS TRIED; (2) THE LACK OF AVAILABLE WATER TO USE WATER FOR PRESSURING THE LINE. THE DIFFICULTY AND TIME LIMITATION IN OBTAINING WATER FROM THE BRAZOS OR RED RIVERS, THE ONLY AVAILABLE SOURCES WHERE IT WAS ECONOMICALLY AVAILABLE; (3) THE EASE OF LOCATING AND DETECTING LEAKS BY USING AIR WHEN THE AIR IS ODORIZED WITH ETHYL MERCAPTAN; (4) THE EASE OF DETECTING AIR ESCAPING FROM LEAKS BY USING AUDIOPHONE; (5) THE DISPROPORTIONATE COST OF OTHER TEST METHODS; AND (6) THE PRESUMPTION THAT DISPLACEMENT OF OIL BY AIR WAS A COMMON AND SAFE PRACTICE IN THE OIL PIPELINE INDUSTRY.

## PROCEDURE

→ (SHOW SLIDE #2 - GO-DEVIL SCRAPER)

ABOUT TWO WEEKS BEFORE THE AIR TESTS, "GO-DEVIL" TYPE SCRAPERS WERE RUN IN THE OIL STREAM TO CLEAR THE LINE OF DEBRIS.

THE FIRST SCRAPER STUCK IN ONE SECTION OF THE LINE BUT WAS FREED BY STRIKING THE LINE WITH A WOODEN SKID. IT WAS BELIEVED AN ACCUMULATION OF DEBRIS HAD STOPPED THE SCRAPER. OTHER SCRAPERS RAN WITHOUT DELAYS.

*(REVERSE TO SLIDE #1 - DIAGRAM OF LINE)*

→ THE "AIR PROCEDURE" WAS STARTED AT BAYLOR STATION AND A 38 MILE SECTION OF THE LINE TO ARCHER STATION WAS AIR PRESSURED, OIL VACATED AND LEAKS FOUND AND REPAIRED. THE PROCEDURE WAS TO INSERT TWO "HARD RUBBER DISC SCRAPERS" INTO THE LINE. THE HARD RUBBER DISCS WERE THE SAME DIAMETER AS THE INSIDE OF THE 10" PIPE. THE FOLLOWING SLIDE SHOWS THE ONE DAMAGED IN THE EXPLOSION.

→ (SHOW SLIDE #3 - RUBBER DISC SCRAPER)

AIR WAS THEN FORCED INTO THE LINE BACK OF THE SCRAPERS BY FIVE AIR COMPRESSORS, WITH A CAPACITY TOTALING APPROXIMATELY 600 FEET OF AIR PER MINUTE AT A MAXIMUM DISCHARGE PRESSURE OF 90-95 PSI. THE LUBRICATOR OF ONE THE COMPRESSORS WAS USED TO FEED ETHYL MERCAPTAN INTO THE LINE. AS THE AIR COLUMN MOVED THE SCRAPER THROUGH THE LINE, MAINTENANCE MEN FOLLOWED THEM TO KEEP TRACK OF THEIR POSITION AND TO SEARCH FOR LEAKS. AS EACH SUCCESSIVE POINT OF LEAKAGE WAS PASSED, WITH RESULTING LOSS OF AIR, THE SCRAPERS MOVED MORE SLOWLY AND FINALLY STOPPED 27 MILES FROM BAYLOR STATION

AT 10 A.M. DECEMBER 9, 1939. *(REVERSE TO SLIDE #1 - DIAGRAM*

→ EIGHT LEAKS HAD BEEN FOUND. THEY WERE DUG OUT AND *OF LINE)* REPAIRED WITH LEAK REPAIR CLAMPS, WHEREUPON THE SCRAPERS

RESUMED TRAVEL. PLUGGING THE EIGHT LEAKS PERMITTED SHUTDOWN OF THREE OF THE FIVE AIR COMPRESSORS AT BAYLOR. THE SCRAPERS THEN MOVED AT 4 M.P.H. (DOUBLE FORMER SPEED) AND REACHED ARCHER STATION 38 MILES FROM BAYLOR ON DECEMBER 10.

THE FOLLOWING DAY THE LEADING SCRAPER WAS REMOVED AND REINSERTED IN THE UPSTREAM SIDE OF ARCHER STATION. IT HAD FURTHER CLEANED THE LINE BY CARRYING INTO THE SCRAPER TRAP AND STRAINERS A LARGE NUMBER OF ROCKS AND METALLIC OBJECTS, AND A SUBSTANTIAL AMOUNT OF SLUDGE. MOST OF THE LATTER, LARGELY IRON OXIDE, HAD BEEN ROLLED INTO SMALL PELLETS ABOUT THE SIZE OF BIRD SHOT.

NEXT A "GO-DEVIL" TYPE SCRAPER WAS INSERTED AT BAYLOR STATION BEHIND THE AIR COLUMN AT 6:15 P.M., DECEMBER 11, AND CRUDE OIL WAS STARTED THROUGH THE LINE IN BACK OF THE SCRAPER. NOW THE AIR WAS BEING FORCED OUT OF THE BAYLOR-ARCHER SECTION BY THE OIL AND IN TURN AIR WAS BEING FORCED INTO THE ARCHER-RYAN SECTION OF THE LINE.

THE MAINTENANCE CREWS FOLLOWED THE SCRAPER ALL NIGHT AVERAGING ABOUT TWO MILES PER HOUR. OIL WAS PUMPED INTO THE LINE AT BAYLOR WITHOUT INTERRUPTION UNTIL 8:14 A.M. ON DECEMBER 12, 1939. THE 8 A.M. GAUGE SHOWED THAT JUST OVER 19,000 BARRELS OF OIL HAD BEEN PUT INTO THE LINE, PUSHING THE REAR "GO-DEVIL" SCRAPER TO WITHIN ONE-HALF MILE OF ARCHER AND THE FRONT SCRAPER TO WITHIN NINE MILES OF RYAN STATION.

→ (SHOW SLIDE #4 - DIAGRAM OF EXPLOSION AREA)

THIS MORNING, THE MORNING OF THE ACCIDENT, THE DIVISION SUPERINTENDENT WAS WALKING WITH THE CREW. ONE MAN WAS WALKING 25 FEET AHEAD OF THE SCRAPER, TWO MEN WITH THE SCRAPER (ONE ON EACH SIDE OF THE LINE AND ONE BEING THE SUPERINTENDENT), AND THE FOURTH MAN WAS DRIVING THE SUPERINTENDENT'S CAR ABOUT 20 FEET BEHIND THE SCRAPER. THE OWNER OF THE RANCH WHICH THE LINE TRAVERSED AT THIS POINT WAS STANDING ON THE TOP OF A HILL THREE-FOURTH MILE AWAY WHERE HE HAD A FULL VIEW OF THE EXPLOSION SCENE. THE FOREMAN HAD DRIVEN UP AND LEFT HIS TRUCK AND WAS WALKING TOWARD THE GROUP ABOUT 500 FEET AWAY AT THE TIME OF THE EXPLOSION. SUDDENLY, THE SCRAPER STOPPED, THE SUPERINTENDENT MOTIONED THE CAR DRIVER TO STOP WHICH HE DID AND SHUT OFF THE ENGINE. THE TWO MEN KNELT DOWN TO TRY TO PICK UP ANY SOUND OF THE SCRAPER. WITHIN AN ESTIMATED 10-15 SECONDS, THERE WAS A MUFFLED EXPLOSION RIGHT UNDER THEM AND ALMOST IMMEDIATELY A SECOND EXPLOSION. THE FIRST MUFFLED EXPLOSION OCCURRED AT THE SCRAPER AND MERELY BULGED THE PIPE BUT DID NOT BURST IT. THE SECOND EXPLOSION, OR RUPTURE IN THE PIPE, OCCURRED DIRECTLY UNDER THE CAR. THE CAR, WITH THE DRIVER IN IT, WAS HURLED AHEAD IN THE DIRECTION THE SCRAPER HAD BEEN TRAVELING AND OVER THE HEADS OF THE TWO MEN LISTENING FOR THE SCRAPER. THE CAR LANDED ON ITS SIDE 145 MEASURED FEET FROM ITS PREVIOUS POSITION AND ABOUT 14 FEET OFF THE PIPELINE. WHEN IT LANDED,

IT WAS FACING IN THE OPPOSITE DIRECTION.

➔ (SHOW SLIDE #5 - SUPERINTENDENT'S WRECKED CAR)

WHILE THE CAR WAS IN THE AIR A THIRD EXPLOSION OCCURRED TOWARD RYAN STATION ABOUT 145 FEET FROM THE SECOND EXPLOSION AND JUST 20 FEET FROM WHERE THE CAR LANDED. ALMOST SIMULTANEOUS WITH THE THIRD EXPLOSION, A SIMILAR ERUPTION OCCURRED SOME 240 FEET BACK OF THE SCRAPER AND IN THE DIRECTION OF ARCHER STATION. OTHER EXPLOSIONS THEN OCCURRED TRAVELING AT A HIGH RATE OF SPEED THE ENTIRE ALMOST 27 MILES BACK TO ARCHER STATION.

AT ABOUT THE TIME OF THE EXPLOSION, THE FOREMAN GLANCED AT HIS WATCH AND NOTICED IT WAS 7:50 A.M. HE RAN TO HIS TRUCK, DROVE A SHORT DISTANCE TO THE COMPANY TELEPHONE LINE WHICH PARALLELED THE PIPELINE, TRIED TO RING ARCHER STATION BUT WAS UNABLE TO GET THEM BECAUSE THE EXPLOSIONS HAD TORN DOWN THE TELEPHONE LINES. HOWEVER, IN THE OTHER DIRECTION THE TELEPHONE LINES WERE INTACT AND HE WAS ABLE TO GET THE DISPATCHER AT CUSHING, WHO CALLED ARCHER STATION ON THE BELL SYSTEM. WHILE THE DISPATCHER WAS ISSUING INSTRUCTIONS TO THE ARCHER STATION OPERATOR, THE LINE BLEW UP IN THE STATION YARD. THE RECORDS AT ARCHER STATION SHOWED THERE WAS AN ELAPSED TIME OF ABOUT EIGHT MINUTES BETWEEN THE INITIAL AND FINAL EXPLOSION, INDICATING AN AVERAGE VELOCITY OF ABOUT 300 FEET PER SECOND FOR THE 26.8 MILES.

(205 mi. per hr.)

THE RANCH OWNER, PREVIOUSLY MENTIONED, WHO WAS STANDING ON A HILL WITH A GOOD VIEW OF THE SCENE OF THE FIRST SERIES OF EXPLOSIONS, STATED THAT THEY THREW UP GREAT CLOUDS OF DUST AND "TRAVELED FASTER THAN AN AIRPLANE". HE WAS ABOUT THREE-QUARTERS OF A MILE FROM THE LINE AND SAW THE LAST VISIBLE ERUPTION GO OVER A HILL TO THE WEST, A DISTANCE OF 1-1/2 MILES, BEFORE HE HEARD THE SOUND OF ANY EXPLOSIONS.

TWO MEN WHO WORKED FOR A GAS COMPANY WERE DRIVING DOWN A HIGHWAY. THEY SAID THE EXPLOSIONS THREW DUST AND WHITE SMOKE 60 FEET INTO THE AIR AND "LOOKED LIKE A LOCOMOTIVE COMING DOWN THE LINE BELCHING WHITE SMOKE BUT TRAVELING MUCH FASTER THAN A LOCOMOTIVE."

THERE WAS ONLY ONE SLIGHT INJURY IN THIS ACCIDENT, AND IT WAS A MINOR ONE. IT WASN'T THE DRIVER OF THE SUPER-INTENDENT'S CAR. HE WAS NOT INJURED AT ALL BUT PLENTY SCARED. THE INJURED PERSON WAS A WPA WORKER ON HIS WAY TO WORK ON THE ROAD. HE DROVE INTO ONE OF THE BIG CRATERS THAT HAD BLOWN OUT IN THE PIPELINE-ROAD CROSSING. HE WAS TAKEN TO A HOSPITAL, EXAMINED, TREATED FOR MINOR INJURIES AND SHOCK AND DISMISSED. HOWEVER, HIS 1931 STUDEBAKER CAR WAS PRETTY WELL WRECKED.


→ (SHOW SLIDE #6 - WRECKED WPA WORKER'S CAR)

### CAUSE OF EXPLOSION

SEVERAL THEORIES AS TO THE CAUSE WERE EXAMINED, HOWEVER, THE THEORY THAT SEEMS TO CORRESPOND MOST PRECISELY TO ALL THE



KNOWN FACTS IS THAT THE SCRAPER,

 (SHOW SLIDE #7 - WOODEN PIPE SKID)

PROPELLED BY AIR ESTIMATED TO HAVE BEEN COMPRESSED UNDER APPROXIMATELY 125 P.S.I. GAUGE PRESSURE AT THE POINT OF EXPLOSION, STRUCK AND ATTEMPTED TO PASS A LARGE WOODEN OBJECT IN THE BOTTOM OF THE LINE; NAMELY, A PIPE SKID, ORIGINALLY 4" X 4" X 36" LONG BUT TAPERED TO 2" X 4" AT ONE END DUE TO WEAR. THE SCRAPER WAS AN INSULATED METALLIC OBJECT, BY VIRTUE OF THE FOUR NEOPRENE DISCS AND THE OIL FILM ON THE WALL OF THE PIPE. THIS OBJECT WAS ELECTROSTATICALLY CHARGED BY SLIGHT LEAKAGE OF HIGH PRESSURE AIR AT HIGH VELOCITY. THE WEDGE EFFECT OF THE WOODEN OBSTRUCTION WAS SUFFICIENT TO FRACTURE THE SLEEVE ON THE SHAFT OF THE SCRAPER, THEREBY PRESENTING, AT THE MOMENT OF FRACTURE, TWO VERY CLEAN AND BRIGHT IRREGULAR METALLIC SURFACES WHICH WERE IDEAL FOR THE DISCHARGE OF AN ELECTROSTATIC SPARK, AND WHICH HAD NOT PREVIOUSLY OCCURRED IN THIS SECTION OF THE LINE.

THE RESULTING SPARK IGNITED A COMBUSTIBLE MIXTURE OF HYDROCARBONS AND AIR, WHICH STARTED THE INSTANTANEOUS PROPAGATION OF A FLAME IN BOTH DIRECTIONS AND CAUSED A MUFFLED EXPLOSION AT THE SCRAPER. THIS FIRST EXPLOSION WAS NOT SUFFICIENT TO RUPTURE THE PIPE BUT BULGED THE BOTTOM OF IT. THE FLAME, TRAVELING AT THE RELATIVELY SLOW RATE OF APPROXIMATELY TWO FEET PER SECOND, IGNITED A HIGHLY COMBUSTIBLE GASEOUS MIXTURE APPROXIMATELY 16 FEET BACK OF

16.8 miles Youngstown Pipe

10 " " British Pipe

one piece of 10" pipe - 13 feet long was found  
370 feet from orig point.

Investigators

Lawrence O'Donnell

Chief Mechanical Engineer - Texas Gulf area  
Prod. Dept. Shell Oil Co. Houston

G. M. Andrews - Utility Engineer - Wood  
River Refinery, mgf Dept.  
Shell Oil Co - Wood River, Ill.

Don Searr - General Superintendent  
Shell Pipe Line Corp  
St Louis, Mo.

Replacement of the line is expected to  
require 3 weeks and involving a cost  
of \$250,000.

THE SCRAPER, AND PRODUCED AN EXTREMELY VIOLENT EXPLOSION WHICH DEFORMED THE SCRAPER PLATES, BURST THE PIPELINE, AND THREW THE AUTOMOBILE ABOUT 145 FEET ALONG THE LINE TOWARD RYAN STATION. FURTHERMORE, IT PRODUCED TREMENDOUS PRESSURE WAVES ALONG THE INSIDE OF THE PIPE IN EACH DIRECTION, RESULTING IN A SERIES OF EXPLOSIONS WHICH REACHED ARCHER STATION, 26.8 MILES TO THE SOUTHWEST, ABOUT EIGHT MINUTES LATER. IN ADDITION, IT CAUSED AN EXPLOSION SOME 145 FEET TOWARD RYAN STATION. HOWEVER, THE WAVES FROM THIS EXPLOSION ENCOUNTERED A BODY OF OIL WHICH PREVENTED THEIR FURTHER PROPAGATION IN THAT DIRECTION. THE REACTIVE PRESSURE SURGE THROUGH THE BLASTED OPEN END OF THE PIPE CARRIED WITH IT A FEW BARRELS OF OIL WHICH WERE SPRAYED AGAINST THE CAR AND UPON THE SUPERINTENDENT, AND ALSO UPON THE NEARBY GROUND.

### CONCLUSION

1. IT IS EVIDENT FROM THE RESULTING EXPLOSIONS AND DETONATIONS THAT THE LINE CONTAINED A CONCENTRATION OF HYDROCARBONS IN THE EXPLOSIVE RANGE.
2. ALTHOUGH FURTHER INVESTIGATION INDICATED THAT SEVERAL OTHER COMPANIES HAD USED AIR TO CLEAR SHORT SECTIONS OF PETROLEUM LINES IN A SIMILAR FASHION, IT WAS NOT AN INDUSTRY WIDE PRACTICE.
3. THIS ACCIDENT, AND MAYBE ONE OR TWO SIMILAR SINCE, AS WELL AS BUREAU OF MINES EXPERIMENTS, HAVE PROVEN THAT THE USE OF AIR UNDER PRESSURE TO

West Texas area

W. H. Bill Shelley area mgr

Colorado Division

H. M. Norris Div. Supt

DISPLACE LIQUID HYDROCARBONS IN A PIPELINE IS NOT A SAFE PROCEDURE. INSTEAD, THE USE OF WATER OR AN INERT GAS SUCH AS NITROGEN IS RECOMMENDED.

4. YOU CAN BE SURE THAT IN OUR SAFETY PROCEDURES, WE FORBID THE USE OF COMPRESSED AIR TO VACATE PIPELINES AFTER THEY HAVE BEEN IN LIQUID HYDROCARBON USE.

- SAFETY

IN SECTION B-94 OF OUR PIPELINE<sup>V</sup> PROCEDURES MANUAL I QUOTE,

"PIPELINES HAVE LITERALLY BEEN BLOWN OUT OF THE GROUND FOR MANY MILES BY INJECTING AIR INTO THEM TO REPLACE THE CRUDE, PRODUCT OR GAS. THEREFORE, PIPELINE SCRAPERS, PIGS OR BALLS MUST NOT BE FORCED THROUGH A LINE WITH AIR AFTER THE LINE HAS BEEN IN CRUDE OR PRODUCT SERVICE, NOR SHALL AIR EVER BE INJECTED INTO A PIPELINE WHICH CONTAINS OR HAS CONTAINED A FLAMMABLE LIQUID OR GAS. ONLY WATER OR AN INERT GAS SUCH AS NITROGEN MAY BE USED SAFELY FOR SUCH PURPOSES."

5. NOW I WILL SHOW A 16MM SILENT FILM OF THE EXPLOSIONS ALONG THE LINE. A CAMERA WAS HELD OUTSIDE A PATROL PLANE AND THE FILM MADE, BUT IT WILL GIVE YOU A GOOD IDEA OF THE OVERALL DAMAGE.

→ (SHOW 16MM MOVIE FILM)

→ (AFTER MOVIE - SHOW SLIDES#8 TO 28)

6. THE FOLLOWING 2" X 2" SLIDES WILL GIVE YOU A FURTHER IDEA OF THE DESTRUCTION OF THE PIPELINE, NOTE ESPECIALLY HOW THE PIPE IS SHATTERED AND TORN INTO GROTESQUE FIGURES OR SHAPES.

→ (AFTER SLIDES - ANSWER QUESTIONS)

THE END