A Graphic Dramatization of the Flixborough Disaster

Ramin Abhari
NYLON YEARS

LINCOLNSHIRE TOWN OF FLIXBOURGH...

...AND NEARBY CITY OF SCUNTHORPE.

SO WHAT WILL IT BE, PRETTY GIRLS?

MARY'S HERE FROM SHEFFIELD AND WE FEEL LIKE TAKING CHANCES!

SO MAKE US YOUR SPECIAL COCKTAIL, NOBBY!

MID APRIL, 1973

ET VOILA!

MERCI MONSIEUR!

CHAPTER 1. CYCLOHEXANE COCKTAILS
Hey Stella, isn't that Allan Lambert?

Oh, yeah! Didn't he have the biggest crush on you at school? And you kept rejecting him?!

Why don't you go say hi? I'll go talk to Nobby at the bar!

Hi Allan, is this seat taken?

Mary! It's good to see you!

You too Allan! So what have you been up to?

These've been amazing days, Mary! We just started up a new production process at Nypro!

Nypro stands for nylon production, right?

Yes, but we just make caprolactam... our customers make the nylon fibers and fabrics from it.

Okay! So what's this new way of making nylon... I mean, capro... lactam?
"The old process starts with..."

**Cyclohexanone!**

**Caprolactam...**

"Phenol, which is hydrogenated into..."

**But phenol is expensive and in short supply!**

**In the new process we make cyclohexanone by oxidation of cyclohexane.**

So the main difference is the starting material: cyclohexane is half the price of phenol, and there's plenty of it!

Its precursor is benzene that has to be removed from petrol for public health.

"Enough with the science mumbo-jumbo, Allan! When am I gonna buy these magical nylon?"

"Today?! Well please tell me more about this lucky day of yours that you happened to see me after seven years and started production of low-cost nylon!"

"Well Mary, we just started production at the cyclohex unit today!"
"Okay lads, we've all gone over the startup procedure..."

"First, we fill up everything with cyclohexane. Then we get it boiling up the distillation column and pump it back around!"

"Albert! Check off each completed procedure step and make sure we don't skip anything!"

"We have six stirred reactors in a row, connected to each other by overflow bellows! I'd studied the reactor mechanical drawings so much that I felt I could see inside!"

"Wow Allan, are you always this prepared? And what are bellows?"

"We then started steam to the reactor preheater as we got the distillation columns ready...boiling up all the cyclohexane, condensing it, and refluxing some while pumping the rest back to the reactors!"

"Our shift superintendent, Rick Simpson, was at his best as a leader today! He had just returned from training at D.S.M.'s smaller cyclox unit in Geleen, Holland."

"I'm on top of it, Rick! We're on step 14, "turn on the reactor agitators."

"Those are the accordion-looking pipe connections for thermal expansion!"

"That's when Rick asked our field operator, John, to render to close the pressure control valve bypass..."

"Reactor pressure and temperature controls were now in automatic...and ready for the critical next step!"
“OUR NEW OPERATOR, MICHAEL SKELTON, WAS AT THE BOARD!”

CYCLOHEXANE FLOW IS 100 TONS AN HOUR, REACTORS AT 155°C AND 125 PSI GAUGE... NOW? AIR INJECTION?

YES MICHAEL! THE AIR COMPRESSOR IS ON! OPEN THE AIR SUPPLY VALVES NOW!

I CAN SEE WHY HE WAS NERVOUS PUTTING AIR INTO THE HOT CYCLOPETROL STUFF!!

RIGHT, MARY! WE WERE TRAINED TO ALWAYS PURGE THE AIR FROM HYDROCARBON TANKS TO PREVENT FIRE...

“...NOW WE WERE BUBBLING AIR DIRECTLY INTO HOT CYCLOHEXANE!”

“WE KNEW IMMEDIATELY THAT WE GOT A REACTION BECAUSE OF THE TEMPERATURE RISE!”

BUT THE ONLY WAY TO KNOW WE GOT THE RIGHT REACTION IS TO TAKE A SAMPLE!
ANALYSIS WAS COMPLETED IN MINUTES THAT FELT LIKE HOURS! NOW WE HAD THE RESULTS: CYCLOHEXANONE MEETING ALL SPECIFICATIONS FOR CAPROLACTAM!

A CARCINOGEN REMOVED FROM MOTOR FUEL COMBINED WITH AIR TO MAKE AFFORDABLE BEAUTIFUL FABRICS TO CLOTHE THE WORLD!

AND THAT’S WHEN IT STRUCK ME! WHAT WE HAD JUST DONE WAS NOTHING SHORT OF A MIRACLE!

IT WAS ALCHEMY ON AN INDUSTRIAL SCALE!

I’VE BEEN CARRYING ON ALL ABOUT MY DAY! WHAT DO YOU DO, MARY?

I’VE BEEN IN SHEFFIELD... DOING OFFICE WORK AND SUCH. I’M THINKING OF MOVING BACK TO SCUNTHORPE!

OH, OK THEN, UM... THE NYPRO FAMILY DAY IS NEXT SATURDAY... LOTS OF FUN IT IS, ER... SINGLES GO TOO, UM... WOULD YOU...?

I WOULD LOVE TO GO WITH YOU, ALLAN!

NEXT: FAMILY DAY!
CHAPTER 2 - Flixborough, May 1973

Quiet everyone! Ruud wants to say a few words!

He's the managing director...

Shhh!

It's wonderful to see so many of Nupro family gathered today!

Our company was formed nine years ago, at a time when the Dupont-I.C.I. venture held the nylon monopoly in U.K.

How could the once vibrant British textile industry remain competitive when it could only purchase nylon from one supplier?!

Now, thanks to Nupro...

...a new and exciting chapter in the long history of British textile has begun!
NYPRO CONTINUES TO GROW IN THE COMPETITIVE SYNTHETIC FIBERS MARKET THROUGH INNOVATIONS LIKE CYCLOX. THIS TECHNOLOGY IS NEAR AND DEAR TO ME PERSONALLY. IT WAS THE FIRST PROJECT I WORKED ON WHEN I JOINED D.S.M. AFTER GRADUATION FROM DELFT.

NOW I WOULD LIKE TO CHALLENGE OUR ENGINEERS AND OPERATING STAFF TO WORK TOGETHER AND INCREASE PRODUCTION THERE TO DESIGN CAPACITY BEFORE OUR GRAND OPENING NEXT MONTH.

MY FELLOW NYPRONIANS! I WANT TO CLOSE BY THANKING EACH OF YOU FOR YOUR HARD WORK AND LOYALTY!

THERE IS NOWHERE IN THE WORLD I’D RATHER BE THAN RIGHT HERE IN FLIXBOROUGH!

RUDD GAVE SUCH AN INSPIRATIONAL SPEECH! I’M SURE IT MADE EVERYONE PROUD TO BE WORKING AT NYPRO!

I GUESS CORPORATE BULLSHIT SOUNDS BETTER WITH A DUTCH ACCENT!

HAA! BEAUTIFUL AND FUNNY! ALLAN, PLEASE INTRODUCE US TO YOUR FRIEND!

OH SORRY EVERYONE! THIS IS MARY! MARY, THESE ARE SOME OF THE GUYS WHO WORK WITH ME IN THE 'O-SHIFT' – KEITH, ROLAND, JOHN,...

ALLAN, WHAT DO YOU SAY WE ACCEPT RUDD’S CHALLENGE AND FIND A WAY TO SQUEEZE MORE PRODUCT OUT OF THE REACTORS! I HAVE SOME IDEAS....

NO TALK OF WORK ON FAMILY DAY! LET'S GET READY FOR THE TUG-OF-WAR!
YEA C-SHIFT!!

ALLAN AND MARY WIN!!

YOU LOOK STUNNING, MARY!

BUT YOU'D BE EVEN LOVELIER IF YOU LOST THE SARCASM!

WE WIN THE COVETED NYLON SCARF! SO... HOW DO I LOOK WITH IT?

DID YOU SAY SOMETHING AFTER "STUNNING"?

NEXT: WATER IN THE REACTORS!
OKAY KEITH, I HAVE ALL SIX REACTOR SAMPLES!

KEITH, NOTICE HOW ALL THE SAMPLES HAVE WATER IN THEM... SETTLED IN THE BOTTOM WITHOUT STIRRING!

OF COURSE, WATER IS THE REACTION BYPRODUCT! BUT WE ALL THROUGH IT WOULD BE IN THE VAPOUR PHASE!

SEND THEM DOWN, ALLAN! EVERYTHING IS SET UP IN THE LAB FOR ANALYSIS!

THE WATER LAYER IS THICKEST IN R-4! NOW LET’S RUN THE GAS CHROMATOGRAPH ON THE ORGANIC LAYER!

I HAVE THE CONVERSION VALUES FOR R-1 THROUGH R-4!

R-5 IS ALMOST COMPLETE! I HAVE R-6 READY TO BE INJECTED NEXT.

DO YOU HAVE THE G.C. RESULTS FOR R-5 AND R-6?

SO WE ONLY CONVERT SIX PERCENT OF THE CYCLOHEXANE, AND THAT ALL HAPPENS IN THE FIRST FIVE REACTORS!

I’M SURE RUUD AND THE MANAGEMENT WILL BE IMPRESSED BY OUR ANALYSIS!
GOOD JOB WITH THE REACTOR REPORT, LADS! BUT THE D-S-M. ANALYSTS HAVE NOW CONCLUDED THAT...

...EVEN AT 6% CONVERSION AND 50,000 TON/Year OUTPUT, THIS IS THE LOWEST COST NYLON PRODUCTION PLATFORM WITH THE HIGHEST RETURN ON CAPITAL—NOTHING OTHER THAN AN UNLIKELY RISE IN OIL PRICES WILL CHANGE IT!

WHO WOULD'VE GUESSED? A REACTION THAT ONLY GOES TO 60% COMPLETION—WITH 94% DISTILLED AND RECYCLED—WOULD BE MOST ECONOMIC!

THAT’S THE TRIUMPH OF ENGINEERING OVER CHEMISTRY!

IT’S LIKE I’M LIVING A DREAM! I FINALLY HAVE MY DREAM CAR, DREAM JOB, AND DREAM GIRL!

LOOK OUT WORLD! I MADE IT TO NUMBER THREE!

NEXT: A CRUDE AWAKENING!
IN BREAKING NEWS, THE ARMIES OF EGYPT AND SYRIA HAVE LAUNCHED A COORDINATED ATTACK ON ISRAELI FORCES IN THE SINAI AND THE GOLAN HEIGHTS...

IN OTHER NEWS, NEGOTIATIONS BETWEEN THE NATIONAL COAL BOARD AND THE MINERS HAVE BROKEN DOWN AND THE "MINIMUM WORK" STRIKE CONTINUES!

RESPONDING TO U.S. MILITARY ASSISTANCE TO ISRAEL IN THE CURRENT WAR, ARAB OIL EXPORTERS HAVE STOPPED ALL SHIPMENTS OF CRUDE OIL TO SELECTED WESTERN NATIONS, INCLUDING BRITAIN. AN ANNOUNCEMENT FROM THE PRIME MINISTER IS EXPECTED.

AT THIS TIME OF NATIONAL ENERGY EMERGENCY, OUR COAL-FIRED POWER PLANTS MUST OPERATE AT INCREASED RATES TO MAKE UP FOR REDUCTION IN DIESEL-FUELED GENERATING CAPACITY!

WE EXPECT OUR COAL MINERS TO FULFILL THEIR DUTY AND NOT GIVE IN TO RADICAL ELEMENTS WHO PUT CLASS-STRUGGLE AHEAD OF NATIONAL INTEREST!

MR. MCGAHEY, YOUR RESPONSE TO THE P.M.?

MR. HEATH AND HIS TORY APPOINTEES ON THE N.C.B. ARE POLITICISING A PAY DISPUTE! TO THAT WE SAY, NO INCREASE IN COAL PRODUCTION WITHOUT A PAY RAISE!

UNPRECEDENTEDLY HIGH PETROCHEMICAL FEEDSTOCK PRICES AND FORCED POWER-CUTS. THIS IS GOING TO BE A TERRIBLE WINTER, MARY.

OH MY! HOW WILL WE EVER STAY WARM?!
Chapter 5

November 1973

Ruard, our back-up generators can supply 70% of the unit's power. We'll need an additional generator to be completely off the grid!

There's no way we can get a new generator in time...

I'd really hate to change operations just to get around this "3-day-week" nonsense!

I agree, Rick! Especially when the unit is running so smoothly!

Hello? Oh Hi Ruard!

Run with no agitators?

Yes I know the air agitates the reactors...

Yes we'll take a sample and have the lab call you.

Come in John—meet me in the motor control center in 5 minutes.

Clank!

Blood! Hell!

Damn!

AMMMMMMEEEEOO*

Haha! We're off the grid, gents! Sure, our margins are squeezed with high benzene prices—But we'll meet our production targets...

Mr Selman, we're getting the same reactor effluent composition without agitation as we were getting before with it on!

...and I'll take a '71 vintage if you please!
OUGH! TOO MUCH SPLATTER FRYING THESE BLOODY CHIPS!

THAT'S THE WATER IN 'EM. THE HOT FRYING OIL MAKES THE WATER ERUPT VIOLENTLY, SHOOTING SLUGS OF HOT OIL!

YOU KNOW, MARY, THAT'S EXACTLY WHAT'S BEEN HAPPENING AT THE PLANT SINCE WE STOPPED MECHANICALLY STIRRING THE REACTORS TO SAVE ELECTRICITY!

THE AIR INJECTED FOR OXIDATION KEEPS THINGS STIRRED UP SO THE WATER BYPRODUCT LEAVES THE REACTOR AS SUSPENDED DROPLETS—LIKE IT SHOULD!

BUT EACH TIME WE HAVE AN EQUIPMENT PROBLEM DOWNSTREAM, WE SHUT OFF THE AIR TO TEMPORARILY STOP PRODUCTION—AND THE WATER SETTLES TO THE BOTTOM.

LATER WHEN WE HEAT UP TO RESTART REACTION, THE WATER VIOLENTLY ERUPTS, SHOOTING SLUGS OF THE CYCLOHEXANE—JUST LIKE IN YOUR FRYING PAN. WITH THE MOTORS OFF, WE CAN ACTUALLY HEAR A CRACKLING SOUND... FINALLY AIR INJECTION IS RESTARTED WHICH STIRS THINGS AND WE RUN WELL AGAIN.

I'M GLAD MY SUFFERING IS SUCH AN INSPIRATION TO YOU, ALLAN!

NOW EAT THE CHIPS I FRIED FOR YOU, AND COME HELP ME PICK A DRESS FOR YOUR COMPANY CHRISTMAS PARTY!

NEXT:

You are invited to the 1973 Nypro Chemical Co. Christmas PARTY

FOOD • DRINKS • LIVE MUSIC • DANCING • FUN
GOOD EVENING NYPRONIANS!
BEFORE I INTRODUCE THE BAND, I'D
LIKE TO SAY A FEW WORDS ABOUT
THE STATE OF OUR BUSINESS.

YOU ALL KNOW THAT THIS YEAR'S
"OIL SHOCK" HAS THROWN OUR
INDUSTRY OFF THE TRACKS OF
PROFITABILITY. SO WE NEED TO BE
VIGILANT IN MANAGING EXPENSES
AND SEEK CREATIVE LOW-COST
SOLUTIONS TO OPERATIONAL
ISSUES.

BUT I ALSO WANT TO ASSURE
YOU THAT OUR FUTURE IS
BRIGHT! WE HAVE AN ADVANCED
PROCESS TECHNOLOGY FOR
LOW-COST PRODUCTION AND ARE
WELL-POSITIONED TO COMPETE
IN A CYCLICAL MARKET!

OIL FROM THE NORTH SEA WILL
SOON FREE THE U.K. REFINING
AND PETROCHEMICAL INDUSTRIES
FROM IMPORTS! AND NYPRO
WILL BE IN A PARTICULARLY
ADVANTAGEOUS POSITION!

WITH THAT, I WISH YOU AND YOUR
FAMILIES A MERRY CHRISTMAS
AND A SUCCESSFUL 1974!

AND NOW, LADIES AND GENTLEMEN, THE HOTTEST
COVER BAND IN LINCOLNSHIRE... WITHOUT FURTHER
ADO, HERE IS... POLYTHENE JAM!

OMIGOD
ALLAN, I LOVE THIS
SONG! LET'S
DANCE!

I NEED TO
TALK TO KEITH. DANCE WITH
GEOFF AND HIS GIRL!

THANK YOU, MR.
SELMAN... HEY NYPRO,
ARE YOU READY TO
PARTY?!

YEAH!!
Shake it up, baby, now! (Shake it, baby.)
Twist and shout! (Twist 'n shout.)
C'mon, c'mon, c'mon baby, now!
(Come on baby.)
Come on and work it on out! (Work it out.)
Well, work it on out, honey! (Work it out.)
You know you look so good!
(Work it out.)

You know you got me goin' now! (Got me going.)
Just like I knew you would! (Like I knew you would.)

...AND THE WATER ERUPTS VIOLENTLY
SHOOTING CYCLOHEXANE SLUGS
AGAINST REACTOR WALLS. THAT
COULD LOOSEN THE FLANGES
AND LET IT LEAK.

I CAN'T REALLY HEAR YOU WITH THE LOUD MUSIC. I'M
GONNA GET US MORE DRINKS FROM THE BAR!

Well shake it up, baby, now! Twist and shout! C'mon, c'mon, c'mon, c'mon baby, now!
(Come on baby.)
Come on and work it on out!

You know you twist little girl! You know you twist so fine!
Come on and twist a little closer, now,
And let me know that you're mine!

HEY YOU KNOW HOW TO DANCE! WE'RE GOING TO SLOW THINGS DOWN A BIT WITH THIS NEXT ONE...
I look at you all see
the love there,
that’s sleeping,
While my guitar
gently weeps.
I look at the floor
and I see
it needs sweeping,
Still my guitar
gently weeps.

MR. SELMAN,
WHAT DO YOU THINK
MAKES A GOOD
RELATIONSHIP?

I don’t know why
nobody told you
How to unfold your love,
I don’t know how
someone controlled you.
They bought and sold you.

I DON’T KNOW ABOUT
ROMANTIC
RELATIONS, BUT
AT WORK IT’S
ALL ABOUT
COMMUNICATION.

KEITH, IS IT
NORMAL FOR THE BOSS OF
YOUR BOSS’S BOSS TO SLOW-
DANCE WITH YOUR
GIRLFRIEND?

OF COURSE!
IT’S VERY
CONTINENTAL... SHOWS YOU’RE
PART OF THE CORPORATE
FAMILY!

I look at the
World and
I notice it’s
turning,
While my
guitar gently
weeps.
With every
mistake we
should surely
be learning;
Still my guitar
gently weeps.

THEY SHOULD SEND
OUT A MEMO
EXPLAINING THE
PROBLEM... AND
HAVE ME COPIED
ON THE MEMO.

AND WHEN
AN EMPLOYEE SEES A
PROBLEM... HOW
SHOULD THAT BE
COMMUNICATED?

Hey, it looks like
I’m going to be
the designated
driver for the
most handsome
man at the party!

I CAN SEE
WHY ALLAN
ADMIRES
YOU, RULI.

I don’t know how
you were diverted...
No one alerted you.

TAKEN CARE OF
HIM, MARY... HE HAS
POTENTIAL.

MAY I HAVE YOUR
CAR KEYS, SIR?

HERE YOU GO,
MARY.

NEXT: THE BENT SHAFT!
CHAPTER 7  January 1974

FLIXBOURGH

SO DID WE START THE AGITATORS?

YES, BUT NO. 4 Didn't START... IT SEEMS TO BE DAMAGED! WE'RE PULLING IT FOR INSPECTION.

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IT'S BENT! CANNOT RUN WITH IT LIKE THIS.
WE HAVE TO SEND IT OUT TO BE RE-Straightened!

GEOFFREY, I DON'T UNDERSTAND. ALL AGITATORS WERE RUNNING WELL WHEN WE TURNED THEM OFF BACK IN NOVEMBER. WHAT COULDN'T HAVE HAPPENED TO DAMAGE IT?

AND WHY ONLY REACTOR NO. 4?

RICK, BECKERS HAS CONTACTED MR. SELMAN AND THEY WANT US TO BLIND OFF THE NO. 4 AGITATOR FLANGE AND RESTART IMMEDIATELY.

SHOw'S OVER LADS! LET'S RETURN TO THE CONTROL ROOM... WE HAVE A PRODUCTION LINE TO RESTART!

WE RAN TWO MONTHS WITH NO AGITATORS... I'M SURE WE'LL BE FINE NOW WITH FIVE OUT OF SIX STIRRING LIKE THEY SHOULD!
WE ALL KNOW THAT ALLEN! YOU STARTED AS A LAB TECH LIKE ME, AND NOW YOU ARE A PRODUCING OPERATOR! BUT UNTIL YOU GET YOUR ENGINEERING BACK TO YOU PROFESSIONALLY, I WILL NOT LISTEN TO YOU PROFESSIONALLY.

I SAW YOUR VEGETABLES AT THE DANCING WITH RUDI!

HER, I HAVE POTENTIAL!

I HAVE THE EIGHT O'CLOCK SAMPLES...

JUST LEAVE THEM ON THE BENCH...

YOU WENT TO TOWN WITH SAMPLES LAST SUMMER, WASN'T IT?

THANKS... I GUESS... I'M THINKING MY NAME, AND ONLY NO. 4.

R Hub ASGATOR FLANGE IS SEALED! YOU CAN PRESSURE HER UP AND GET THINGS BACK ON LINE!
FINALLY WE MEET THE MARY WE’VE HEARD SUCH WONDERFUL THINGS ABOUT!

HI MUM!

THANKS FOR HAVING US OVER, MRS LAMBERT.

MRS LAMBERT, LET ME HELP YOU THERE PLEASE.

HI DAD! HOW ARE YOU FEELING?

UM... OKAY. JUST SIT WITH ME AND WATCH THE MATCH...

...LEEDS IS UNSTOPPABLE!

DAD, HAVE YOU SEEN ANY OF HOLLAND’S MATCHES? THEY PLAY AN ATTACKING SYSTEM THEY CALL “TOTAL FOOTBALL!”

MRS LAMBERT, MAY I SERVE THE TEA?

SO YOU’RE STILL HAPPY AT NYPRO?

YES DEAR. THANKS!

YES DAD, I LOVE IT THERE!

YOU KNOW I ONLY FOLLOW ENGLISH FOOTBALL.

IT SEEMS MOST INNOVATIONS IN EUROPE ARE COMING FROM THE NETHERLANDS... BE IT FOOTBALL OR PTEROCHEMICALS!

MRS LAMBERT, WHY DON’T WE PLAN ON WATCHING THE WORLD CUP TOGETHER THIS JUNE? IT’S TOO BAD ENGLAND Didn’T MAKE IT, BUT WE HAVE SCOTLAND TO SUPPORT! AND WE SHALL SEE IF DUTCH FOOTBALL IS AS AMAZING AS ALLAN SAYS!

CUP OF TEA, MR LAMBERT?

OH MY, OF COURSE! LOVELY GIRL YOU ARE, MARY!

WHAT A GREAT IDEA! I FINALLY HAVE A REASON TO BUY A COLOUR TELE!

NEXT: CRACKS AND BREAKUPS!
CHAPTER 8

27 MARCH '74
NIGHT SHIFT

LOSS OF CONTAINMENT FROM REACTOR 5!

ACTIVATE THE ALARM! DO YOU COPY?!
I have the fire extinguisher, Allan!

It's coming from the R-5 inlet nozzle... point and spray to disperse the bloody thing before it ignites!

I turned off the cyclohexane pump, Albert. Now open the vent valve! We need to de-pressure in a hurry!

Just opened it, Rick!

We're not depressing fast enough!

John, go open the bypass valve! Every second counts!
PRESSURE, ALBERT? WE NEED TO BE BELOW 20 PSI FOR THE RELEASE TO STOP.

80 PSI!
COME ON DAMN IT! FASTER!!

FINALLY! 14 PSI!
THANK YOU, LORD!

WE'RE RUNNING OUT OF EXTINQUISHER WATER! AND THE BLOODY THING IS SPEWING LIKE THERE'S NO TOMORROW!

107 PSI, AND TEMPERATURE DOWN TO 140°C FROM FLASH COOLING.

THAT'S IT—WE'RE OUT! BUT IT IS STILL COMING!

IT'S OVER! THANK YOU, PATRON SAINT OF IGNITION SOURCES!!

SOUND THE "ALL CLEAR!" THEN STRIP THE INSULATION FROM LOCATION OF THE RELEASE.

I WILL CALL BECKERS AND SELMAN FOR GUIDANCE ON HOW TO PROCEED.
Everyone's here for the unveiling!
Yeah, we all want to see what's behind our exciting night!

Wow! Look at the size of that crack!

I'm no metallurgist, but I've seen many corroded steels in my years...

...this is definitely stress corrosion cracking!

...that, I think, came from the water in R-4 that isn't mixed. Water that violently erupts in No. 4 hits the inlet nozzle of R-5! The impact puts plenty of stress there.

What do you think Allan? What would make a couple-inch-thick steel crack like that?

I'm not sure about the chemical that initiated the corrosion. But for "stress corrosion cracking," you also need tensile stress...

That's likely how the No. 4 agitator got damaged when we were running with motors off! You see? Both failures are explained by absence of mixing in R-4!

There's going to be an engineering staff meeting tomorrow to decide on a course of action. They'll need the "conversion curve" you two prepared last summer. Drop that off before you leave.

This is great, Keith! We had plotted water content along with cyclohexane conversion. Looking at that, it should be self-evident that free water is the culprit, and we need agitation in R-4.
OH MARY, I WAS FACE-TO-FACE WITH THE MOST DESTRUCTIVE FORCE I'VE EVER SEEN.

A HYDROCARBON VAPOUR-AND-AEROSOL MIXTURE... EACH AEROSOL DROPLET CONTAINING POTENT OXIDATION CATALYST!

WE WERE JUST A SPARK AWAY FROM HELL-FIRE.

WE HAVE TO PUT A WORKING AGITATOR BACK IN R-4... MUSTN'T START WITHOUT IT.

IT WAS THE NIGHT SHIFT FROM HELL!

ONE OF OUR REACTORS CRACKED OPEN!

THE CATALYST IS AN ACCELERATOR FOR ALL OXIDATION REACTIONS... INCLUDING COMBUSTION! THE AEROSOL-VAPOUR CLOUD LINGERED ABOVE.

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RICK, WHAT'S THE PLAN? ARE WE GOING TO WAIT UNTIL R-5 IS REPLACED AND WE HAVE AN AGITATOR IN R-4 BEFORE COMING BACKUP?

ALLAN, THAT WOULD TAKE MONTHS! RUIDI CHALLENGED THE TECHNICAL STAFF TO COME UP WITH A WORK-AROUND THAT WOULD HAVE US UP AND RUNNING IN DAYS!

FIRST, WE CONFIRMED THAT NONE OF THE OTHER REACTORS SHOW ANY SIGN OF STRESS CORROSION CRACKING.

"THEN THE ENGINEERS LOOKED AT THE CONVERSION DATA AND CONFIRMED THAT VIRTUALLY ALL THE OXIDATION HAPPENS IN THE FIRST FIVE REACTORS. ALL WE NEED TO RUN IS FIVE WORKING REACTORS!"

"THEY CAME UP WITH A PIPE DESIGN FOR FLOWING DIRECTLY FROM HIGHER R-4 TO LOWER R-5. THE CRACKED R-5 IS BEING REMOVED FOR METALLURGICAL TESTS AND REPLACEMENT."

"THEY DREW UP THE PROPOSED PIPE ON THE SHOP FLOOR AND THE LADS THERE HAVE ALREADY STARTED FABRICATION!"
I’m sorry they didn’t interpret your graph the way you thought they would, Allan... What was missing was your explanation!

So I have a surprise that might help!

I understand the pressure to restart quickly to meet our commercial targets. However, since we do not yet understand the root cause of the 27 March failure of R-5, we risk a repeat.

I believe the root cause involves water layer in unagitated R-4. I thus urge a delay until a working agitator is installed. While waiting for the agitator, we can have mechanical review of the proposed R4-to-R6 pipe.

It comes with a sexy secretary who’ll help you write a professional memo!

In it, you can explain your concern about rushing to restart without that mixer.

Here we go, from Allan Lambert, to Ruud Selman. Date, 28 March 1974. Subject?

Concerns about modifications to reactor system.

I like it! Now explain the whole thing like you did to me.

Tap! Tap! Tap! Tap! Tap!

Gulp! Gulp! Gulp!

This is stupid! H!

Ha! Ha! What happened to corporate bullshit? Mary?! One dance with the boss and you’re a believer in enlightened management?!

Fine! Forget the whole thing!

No Allan, Ruud told me himself that he values memos that describe problems his employees identify!

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I think we need some time away from each other. The passion and energy you have for your work is what attracted me to you... but now it's a force that is pushing me away!

I want to help... but you show no trust in me.

I will move back to Sheffield tomorrow. Good-bye Allan!

FROM: Allan James
TO: Rudolph Selma
DATE: March 28, 1974
SUBJECT: Concern About No. 5 Reactor

I understand the pressure to meet our commercial targets. However, the root cause of the issue in R-4 is a delay in restarting the water layer in the pipe. We can only restart R-4 once the pipe is cooled. Proposed R-4 to R-6.
NEXT:
LAST POSTCARD FROM FLIXBOROUGH
Flixborough, 7 April 1974

Dear Mary,

I'm sorry I lost my temper. I just felt so powerless at that moment. Things around me were changing and I had no say in the matter. Your faith in my ability to influence the events with my words just added to the pressure - and perhaps brought out my working class insecurities. I became angry and said hurtful things. Sorry.

Well, we've been up and running, making the product that keeps our customers' nylon lines spinning. Everyone's happy!

Maybe I was unnecessarily concerned. I don't know. The temporary pipe supported by scaffolds is now an integral part of the process. R-4 still has no agitator. And it all seems normal now. You see? Our perception has changed.

Love, Allan
WEDNESDAY, 29 MAY

Drip! Drip! Drip!

CHAPTER TEN

The leak from the neutralizer sight glass valve has gotten bad! Over!

Drip!

Roger that!

Okay we're going to shut down the reactors, fix the leak, and start right back up!

Roger!
FRIDAY, 31 MAY

THE LEAK WAS FIXED YESTERDAY! CAN'T BELIEVE WE HAVEN'T LINED OUT YET!

THE A-SHIFT REPORTED PROBLEMS WITH SUDDEN PRESSURE SPIKES, RICK!

THE First thing after cyclohexane circulation, we pressurize the reactor system to 60 psi with nitrogen...

"To do that, we have to close the manual vent block-valve upstream the pressure control valve (PCV). That's because the PCV doesn't close completely and we'd vent nitrogen if it isn't blocked!

"The temperature control may be put in auto at 155°C set-point by closing the bypass valve. Do that anytime after reactors reach 140°C."

"Cyclohexane vapour pressure increases with temperature. When pressure reaches 120 psi, open the PCV block-valve for auto-control with 125 psi set-point."

"Once at 60 psi we shut off the nitrogen and opens the steam controller bypass valve to heat up the reactors.

ONLY

AFTER REACTOR TEMPERATURE AND PRESSURE HAVE LINED OUT AT SET POINTS DO WE START AIR SUPPLY!

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HOW ARE WE COMING ALONG ALBERT?

I'M NOT SURE ALLAN...

...TEMPERATURE IS ONLY 140°C AND PRESSURE'S ALREADY AT 120 PSI!

WE OPENED THE VENT BLOCK VALVE... BUT THERE'S NO WAY NOT TO OVER-PRESSURE IF WE HEAT TO 155°C.

THE PROCEDURE ASSUMES WE RIDE THE VAPOUR PRESSURE CURVE! BUT WE ARE SEEING A DISCONTINUITY AT AROUND 140°C -- A SUDDEN SPIKE IN PRESSURE THAT WE'RE MANAGING BY MANUAL VENT.

RICK, WE NEED TO TALK ABOUT THE STARTUP PROCEDURE.

I THINK THAT'S BECAUSE OF THE SETTLED WATER IN UNAGITATED R-4 THAT SUDDENLY ERUPTS AT AROUND 140°C!

SINCE THE ONLY WAY TO AGITATE THE R-4 IS WITH AIR INJECTION, WE NEED TO START THAT A.S.A.P!

THE LONGER WE DELAY AIR INJECTION, THE GREATER THE EFFECT OF WATER LAYER ERUPTING AND RESETTING...

NO! AIR INJECTION IS A CRITICAL STEP ALLAN...

...WE WILL NOT DEVIATE FROM PROCEDURE OVER THE WEEKEND.

WE CAN DISCUSS IT WITH THE ENGINEERS ON MONDAY.
**FRIDAY 31 MAY, 11 P.M. SHIFT**

**BLOODY HELL! PRESSURE JUST SHOT UP AGAIN... GOTTA VENT.**

**SATURDAY 1 JUNE, 3 A.M. SHIFT**

**I THINK I'M HOLDING PRESSURE OF 125 PSI AT 150 C - BUT ONLY WITH VENT VALVE 20% OPEN AND NITROGEN SUPPLY ON.**

**YOU'RE WASTING NITROGEN MAN!**

**SATURDAY 1 JUNE, 11 A.M. SHIFT**

**YES, I'M CALLING FROM NYPRO TO REQUEST A NITROGEN DELIVERY... TODAY!**

**RICK, TAKE A LOOK AT THESE STRIP CHARTS! THEY STRUGGLED WITH PRESSURE CONTROL ALL DAY!**

**ALLAN, WE'LL KEEP IT IN HOT CIRCULATING WITH THE VENT VALVE CLOSED UNTIL NITROGEN DELIVERY.**
I'll go wait for the nitrogen trailer...

The vent block-valve is closed to conserve nitrogen. But if he's right about a pool of water in E-4, hot circulation with vent closed may be a bad idea...

Dear God! It's shaking!

The dog-leg pipe is shaking! Shut off the steam!

But we're still below 150 C!

John! Close the steam valve and open the vent block valve!

It's that pressure spike at 140C... With vent valve closed, it could've pushed the pipe to squirm at the bellows!
4:52 P.M.

Shut off the cyclohexane pump and start depressurization!

It's already depressuring...venting everything out into the open!!

Get your respirators and grab an extinguisher! We need to prevent it from igniting.

28 men against 50 tons of flashing cyclohexane... do we even have a chance?!

What's happening Allan?!

Can't talk! Get everyone in the lab and evacuate! The sky above us is turning into a bomb we need to defuse! Leave now!!
Our attempt at dispersing the vapour cloud with extinguisher spray has failed!

Yes... the cloud has only grown.

It's now stretched all the way to the hydrogen plant...

...and it's top-fired reformers!

Has everyone evacuated, Allan?

Yes Rick... everyone but us here and in the control room.

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THIS JUST IN... A LARGE EXPLOSION AND FIRE HAS BEEN REPORTED AT THE NYPRO CHEMICAL PLANT IN FLIXBOROUGH. FIREFIGHTERS ARE TRYING TO CONTAIN WHAT'S BEEN DESCRIBED AS A MASSIVE INFERNO.

IT'S ONLY EMERGENCY VEHICLES BEYOND THIS POINT. NOT SURE YOU'D WANT TO GO FURTHER... IT LOOKS LIKE A WAR ZONE!

I'M RUUD SELMAN, MANAGING DIRECTOR OF NYPRO. HOW ARE MY EMPLOYEES?

WILLEM, IT'S BEYOND ANYTHING I'VE EVER SEEN.

GET A GRIP MAN! WE WILL BE JUDGED AS A COMPANY BY HOW WE RESPOND TO THIS ACCIDENT... AND I INTEND TO RESPOND AS A PETROCHEMICAL LEADER!

28 EMPLOYEES DIED! I KNEW THEM WELL (SNiff) I KNEW THEIR FAMILIES...

THE QUESTION, RUUD, IS DO YOU HAVE WHAT IT TAKES?

NO SURVIVORS AMONG THE WORKERS INSIDE... GO SEE THE FIRE CHIEF.

WERE YOU MAKING EXPLOSIVES IN THERE?

Uh NO, JUST CAPRO... NO SURVIVORS?!
SHEFFIELD, 3 JUNE

The Daily Mail: 'Inferno at Flixorough. 500 workers killed.'

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JAMES DOHERTY, 46, CAME TO NYPRO IN MAY 1972 AFTER LEAVING HIS HOMELAND OF IRELAND BECAUSE OF THE “TROUBLES.” JAMES LIVED IN SCUNTHORPE WITH HIS WIFE ZETTE AND THEIR CHILDREN, SHARON, HELEN, AND DIANE. HE LIKED GOLF, SEA-FISHING, AND MOTORING.

MICHAEL “NOBBY” CLARK, 26, LIVED IN SCUNTHORPE WITH HIS WIFE PAMELA AND THEIR SONS, GARY AND JASON. MICHAEL WAS A FORMER MEMBER OF THE ROYAL AIR FORCE. HE LIKED TO HANG OUT AT THE DESERT RAT WHERE HE FREQUENTLY ASSISTED BEHIND THE BAR.

WAYNE BRADSHAW, 19, WAS THE YOUNGEST OF THE WORKERS KILLED BY THE BLAST. HIS FATHER BOB AND BROTHER STEPHEN ALSO WORKED AT NYPRO. WAYNE HAD JUST COMPLETED A PROCESS OPERATOR COURSE AT THE NORTH LINDSEY COLLEGE OF TECHNOLOGY.

GEOFFREY MARSHALL, 20, LIVED IN SCUNTHORPE. GEOFF WAS A MINE OF INFORMATION ON FOOTBALL TOPICS AND WAS FREQUENTLY CALLED TO SETTLE AN ARGUMENT. HE HIMSELF WAS A KEEN LIVERPOOL SUPPORTER AND HIS MINI WAS DECORATED IN THE COLOURS OF HIS FAVOURITE TEAM—RED AND WHITE! WHenever HE COULD FIND TIME HE WOULD ATTEND MATCHES.

FREDERICK WATKINSON, 33, JOINED NYPRO IN MAY 1973 AFTER LEAVING CIBA CHEMICALS. FRED AND HIS WIFE SHEILA HAD FOUR CHILDREN, THREE GIRLS AND A BOY, ALL UNDER EIGHT YEARS OF AGE. THE FAMILY HAD JUST MOVED TO THEIR NEW HOME THREE DAYS BEFORE THE TRAGEDY.

GRAHAM RICHARDS, 30, LIVED WITH HIS WIFE JACKIE AND TWO SONS, ANDREW AND DAVID. HE WAS KNOWN AMONG OTHER PROCESS OPERATORS FOR HIS QUIET AND DRY HUMOUR. GRAHAM WAS WORKING TOWARDS A DEGREE IN SOCIOLOGY AND ECONOMICS AT THE OPEN UNIVERSITY.

THOMAS CROOKES, 58, WORKED AT THE GUARD HOUSE. HE LEFT A WIFE, HILDA, AND TWO CHILDREN, STEPHEN AND KAREN. HIS DUTY COLLEAGUE THROUGHOUT HIS EMPLOYMENT WAS HARRY HOLLAND WHO HIMSELF SUSTAINED INJURY AND LOST HIS SON IN THE DISASTER.
JOHN RENDER, 20, lived with his parents in Burton-on-Sather. He was engaged to be married to Jane Holmes. John was one of the star players with Burton Athletic Football Club.

In addition to being a first-class all-around athlete, John also liked to paint. His art was inspired by nature.

MICK HICKSON, 26, joined the company in 1967 as a process control technician. He met his wife Marina at NYPRO. The two lived in Flixborough. Mick was serious about advancing his career and had obtained two controls certificates. He was interested in camping and had just bought a caravan. Mick was an ardent supporter of Leeds United.

RONALD FORESTER, 23, lived in Scunthorpe with his wife Denise and their eight month old son, Marc. Ronald’s parents and brother had also worked at the plant. Ronald and Denise’s son had been christened the Sunday before the accident.

EDWIN HOLLAND, 24, lived in Scunthorpe with his wife Shirley and their seven month old baby daughter, Nicola Jayne. Edwin had just left British Steel to work for NYPRO. His father, Harry, served on the NYPRO security staff and was on duty the day Edwin died.

ANTHONY FREAR, 30, lived in Scunthorpe with wife Joyce and their sons, Paul and Richard. He was a skilled bricklayer and was in great demand for his custom-built fireplaces. Tony was proud of his record collection and hi-fi equipment.

KEITH WINTER, 24, lived in Scunthorpe with his wife Jill. He joined the company after graduating from Newcastle University with a degree in Chemical Engineering.

ALBERT NUTT, 51, lived in Guiness. Before joining NYPRO in February 1973, Albert was injured in an industrial accident that left him handicapped. He came from a large family and had four surviving sisters and brother.
HARRY STARK, 44, LIVED IN SCUNTHORPE WITH HIS WIFE JESSIE AND THEIR SONS COLIN AND PAUL. THEY HAD JUST MOVED INTO A NEW HOUSE ON BROOK DALE ROAD WHERE HARRY WAS DOING HIS OWN RENOVATION.

ALLAN LAMBERT, 25, WAS HIRED AS A CHEMIST BUT BECAME A PROCESS OPERATOR DURING THE STARTUP OF THE CYCLOHEXANE OXIDATION UNIT. HE WANTED TO ADVANCE HIS TECHNICAL CAREER AND WAS ENROLLED AT THE NORTH LINDSEY COLLEGE OF TECHNOLOGY, PURSUING A DEGREE IN CHEMISTRY.

JOHN BARRETT, 43, LIVED IN KEARNY WITH HIS WIFE LILIAN AND THEIR TWO CHILDREN. HIS HOBBY WAS WOODCARVING.

ROLAND CRIBB, 35, LIVED IN SCUNTHORPE WITH HIS WIFE ZETA AND THEIR CHILDREN TREVOR AND DIANE. HE LIKED TO PLAY CRICKET AND WAS A DEDICATED SUPPORTER OF SCUNTHORPE UNITED FOOTBALL CLUB.

KENNETH CRAWFORD, 35, LIVED IN ASHBY WITH WIFE AGNES AND CHILDREN, PAUL, SUSAN, AND JAMES. HIS HOBBIES INCLUDED GARDENING, FISHING, AND CAR MAINTENANCE.

GEOFFREY TWIDDLE, 30, LIVED IN ASHBY WITH WIFE PAULINE AND DAUGHTERS KAREN AND ANGELA. HE LIKED READING SCIENCE FICTION AND HAD AN INTERESTING HOBBY OF MAKING ELECTRONIC MUSICAL INSTRUMENTS.
DENNIS LAWRENCE, 48, lived in Scunthorpe with his wife MARGARET and daughters HEATHER, HILLARY, JACQUELINE, and BEVERLY. He joined Nypro in March 1969 as a process technician. Dennis was active in the company social club, and acted as Father Christmas at the children’s Christmas parties.

THOMAS LEIGHTON, 40, joined Nypro in January 1971 as an instrument technician. He lived in Flixborough with wife IRENE and children, LINDA, DAVID, and SUSAN. Tom’s hobbies included watch-repair and model-making (amongst them several magnificent ships.)

STANLEY GRUNDY, 48, lived in Briggs with wife NELLIE and two children, RUSSELL and MARK. He was loading a tanker truck at the time of the blast.

MICHAEL SKELTON, 27, lived in Flixborough with his wife LESLEY CHRISTINE. He was previously a bread salesman and well respected in the community.

STEPHEN DRURY, 27, lived in Burton-on-Slather with wife SUSAN and only daughter SAMANTHA. He joined Nypro in June 1973 as a process operator. Steve was quiet and enjoyed “do-it-yourself” projects around the house.

IAN KIDNER, 37, lived in Scunthorpe with wife MARION and children ADELE and JOHN. He came to Nypro in July 1968 after leaving the steel industry. Ian had served in the Royal Air Force and was an excellent instrument technician.

RICK SIMPSON, 34, lived in Scunthorpe. He was divorced with two children. At the time of the accident, Rick was engaged to marry VANESSA DALY. He was the shift superintendent and had attended training at the DSM Petrochemical Complex in Geleen, Holland.