SUBMISSION TO THE AUSTRALIAN TRANSPORT SAFETY BUREAU, A380 INVESTIGATION

Thank you for sending the A380 Preliminary ATSB Report dated December 2010.
I retired as a Flight Engineer 16 years ago, years before Qantas disposed of its last Flight Engineer.

I assume that all procedures are developed around an operating crew of 2 Pilots
I have read the preliminary report, and am amazed to see that 5 A380 Licensed Pilots.(inc. 3 Senior Captains) have not reported any reactions or comments, concerning the #2 engine during the period between advancing thrust to 87% and significant engine abnormalities occurring during the period 0200.22 through 0201.07.
I understand that this is a preliminary report; however it appears that the first crew reaction to a problem existed when they heard "two loud bangs" followed by a "slight yaw", and an "overheat" warning in #2 engine turbine at 0201-08.
I have taken information from the graphs contained in the report and transferred them to a chart of #2 engine indications/against time. - Copy enclosed. (to the best of my age reducing ability). I submit the following remarks and queries and trust that they may assist with the Ongoing Investigation Activities.

During the Flight in Question. Did the Crew recognise any of the developing #2 engine faults or discrepancies –

1. From start up #2 engine oil pressure was lower than the other 3 engines.
   0200.22 After setting 87% thrust
2. #2 Engine oil pressure began to drop further. #2 Engine oil temp rose gradually above the other 3 engines.
3. 0200.56 #2 engine Vibration started to fluctuate – then rose rapidly to 2.8
4. 0201.00 N2 and N3 changed speed at the same time as the vibration further increased to 3.7 accompanied by an uncontrolled drop in N1 of .8%.
5. (a) as result of 3 & 4 above, was reducing the thrust of #2 engine to idle considered?
   or
   (b) was an immediate shut down considered?
6. 0201.07 Did the Crew consider a 'LAST DITCH" opportunity to shut down #2 engine with - N1, N2, N3 decreasing rapidly – "2 loud bangs"/Stall.
   EGT rises rapidly due to limited fuel still supplying the engine (after P30) (fuel flow is not shown on report graphs.)

FOLLOWED BY ECAMS INDICATIONS

0201.08	TURBINE O/HEAT
0201.10	Disc failure
0201.11	Pylon O/heat

Some sudden vibration at 0200.54 is worthy of note, but not immediately serious.
However, rapidly increasing vibration accompanied by multiple large engine spool

fluctuations commencing at 0200.59, is time to become rapidly serious about an engine shut down.

I have restricted the above comments to the period of flight prior to, and including, the #2 engine turbine overheat and disc failure, after which the aircraft passed into the recovery phase.
The Second Officer later, (time unknown) reported seeing fuel pouring from #2 engine area, (a very hot, explosive engine in fire mode.)Was this before or after the #2 engine master switch was TURNED OFF? This action may not have shut off fuel to the engine for the same reason fuel could not later be shut off to #1 engine.

Does the A380 Cockpit still contain engine Instruments? Have we disposed of the Flight Engineer, lost the engine instruments, and replaced them both with a TOO LATE COMPUTER called ECAMS !!? Obviously I am not up to date with the A380, its procedures or its instrumentations.

Parameter changes, to trained eyes, are NOT difficult to recognize – they stand out when aligned with 3 other engines that are normal. Someone needs to be LOOKING AND MONITORING, especially after high thrust is applied and changed. (e.g. Take Off and Climb, as with A380) This period of highest work load on engines unfortunately is accompanied by the highest workload period for the two Pilots.
It is the responsibility of a F/E to notice and record such things as oil pressures lower than others, oil temps higher than others, and watch for further developing indications. He must be aware of small changes in Aircraft Parameters. It is in his engineering blood to notice abnormalities when thrust levels are changed (eg 72 to 87%) and immediately draw those discrepancies to the attention of all Crew Members.
Flight Engineers are trained in a simulator to be ultra observant of all aircraft parameters with a particular emphasis on engine parameters during high thrust periods. Satisfactory reactions and execution of this ability in a simulator is a condition of his licence. Simulator programs practice many different engine and system possibilities.

IT APPEARS SIGNIFICANT THAT SIMULATOR PERIODS COMPRISING TWO PILOTS AND A FLIGHT ENGINEER REGULARLY PRACTICED ENGINE FAILURE PROCEDURES THAT WERE NOT ONLY SIMILAR (ALL BE IT ON A 2 SPOOL ENGINE) TO THE SYMPTOMS EXPERIENCED ON THE A380 #2 ENGINE, BUT ALSO MIRRORED THE LAPSE TIME OF THE SYMPTOMS.

The F/E is responsible to immediately alert the Captain of any engine abnormality - also the possibility of any developing fault. When a turbine engine fails, it generally fails rapidly, particularly during take off or at high thrust settings. This exercise was the most practiced procedure during every simulator session with a F/E, at least 4 times a year. The A380 failure was tragic and close to being extremely tragic. No doubt this incident will be food for some thinking as the aviation world digests the full implications of what happened in the Cockpit in November, 2010.

The general public, unfortunately, are unaware that nothing of this catastrophic nature occurred in the 45 years of flying in Australia with a Trained Engineer in the cockpit of large turbine aircraft. I believe this achievement is a direct result of dedication to the continuous recurrent training that was a proud culture of the Flight Engineer at QANTAS, TAA, ANA, ANSETT and AUSTRALIAN AIRLINES. This was the period in which QANTAS became known world wide as WORLDS SAFEST AIRLINE. Coincidence? NO.
As was the custom with most large world airlines in the 1950/60s, airlines in Australia introduced selected trained aircraft engineers to train as specialist Flight Engineers.

However, a blind search for economies of operation by Airlines and Manufacturers changed all that. Aircraft and engines have become larger – F/E's discarded and replaced by ever growing racks of automatic black boxes. We now have had a serious in-flight explosion that reportedly cost around $150M. - $80M of which is the aircraft alone. (Merrill Lynch estimate - overall $207M. Some economies!

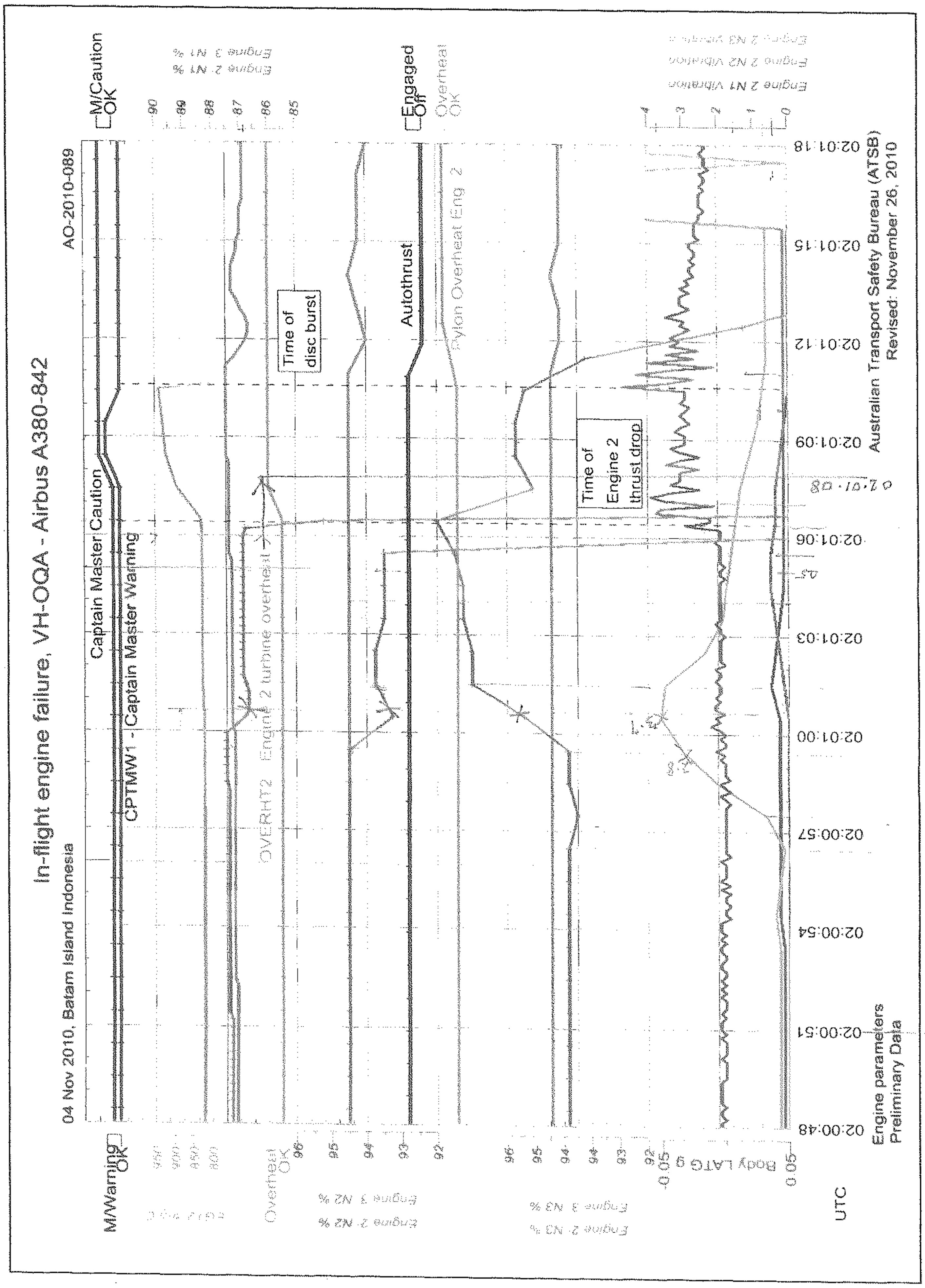
One cannot underestimate the severity of the situation in which the crew found themselves after the engine explosion, the resulting damage to a large number of systems, and the great feat of airmanship shown to place such a damaged aircraft safely on the ground. However, should more have been done to recognize and deal with the developing failure before #2 engine exploded and created the unsafe in-flight situation.

I am sure that the above questions will be answered in your final report. However, I felt passionate enough to present my thoughts after reading the Preliminary Report of December 2010.

Yours faithfully.

G. McArthur

Figure A-2: Graphical representation of engine parameters around time of event

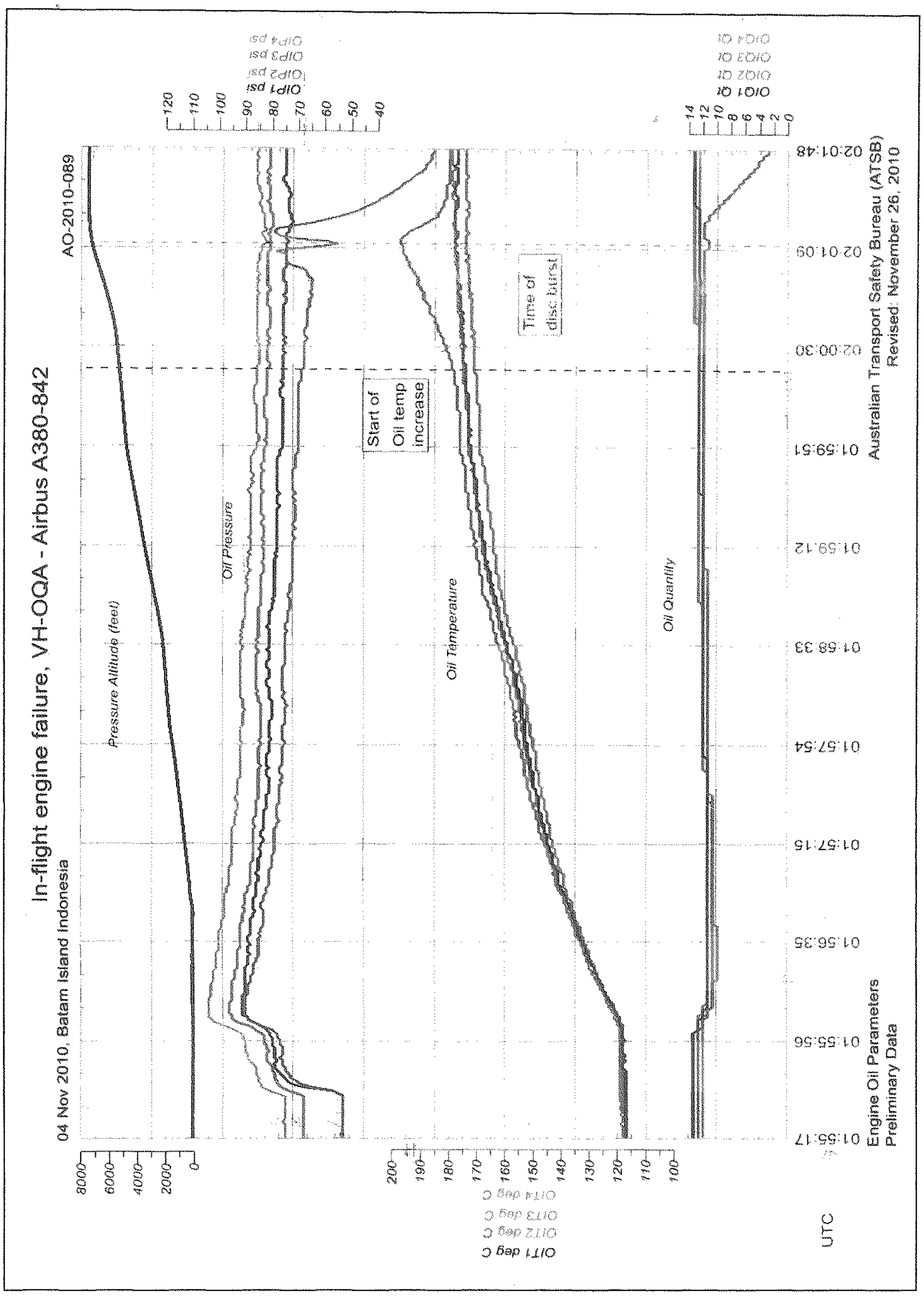


#4 Engine Shut Down S/W — Should erroneously shut off (ie prior to disc failure) Prior to Catastrophic Disc Failure (Cutting wiring?)
1 Fuel to Engine
2 Ignition to Engine
3 Supply Power to fire extinguishing System

Blade Disc Failure — Shut Down Action TOO LATE — Probable failure of power source to above functions due to damage (wiring to #1 ENG Shut Down had been only accessible to shut #1 down after landing)

[None of 1, 2, 3 above were successfully considered] Also, several officers later reported fuel trail from the vicinity of #2 engine — about ½ meter in width

Figure A-3: Graphical representation of engine oil parameters prior to event



Time		N1	N2	N3	EGT (°C)	VIB	O.P (OIL PRESS.)	O.T (OIL TEMP)	Other engines	
	THRUST 72%									
0200.22	INC. THRUST	87.3%	94.5	94.8	825	0.2	68	180	74	175
02.00.30							67	181		
0200.40							66	185		
0200.48										
0200.50					825 °C		66	190		
0200.54										
0200.56		87.4	94.5	94.8		~	65	192	76	176
0200.57				~						
.58				~		1.2	~			
.59		87.5	94.5	↗		2.8				
0201.00		↘	↘	↗						
0201.01		86.8	↗	↗		3.7	70	195	75	176
02		86.8	95.8	→			~			
03		86.8	~	97.3		2.1	↗			
04		86.8	→	→			↗			
05		86.8	93.5	↗		1.6	↗			
0201.06		86.8	↓	↓	825		↗			
0201.07		↓	↓	↘	↗	1.4	↘			
0201.08		↓	↓	↗	↗		↓			
0201.09		↓	↓	→	↗	0.8	↗	196		
0201.10		↓	↓	↘	950 °C		↓	↘		
0201.11		↓	↓	↓	↓	0.7	↓			

FLT. CREW'S FIRST ACTIONS

DATA COMPILED FROM FLIGHT DATA RECORDER GRAPHS ATTACHED

~ indication starting to fluctuate
↗ rising spool speed
↘ falling spool speed

FOR Same N1 of 87%
OP Dropped 3PSI
OT Rose 12°C

0200.22 Between Increase to 87%
0200.56 + start of a serious Engine fault.
0201.00

Increasing Vibration is often positive indication of a severe turbine problem developing.

ENGINE VIBRATION Early Warning of Problem

* THRUST NOT REDUCED
Vibration increasing
Vib / N2 + N3 Fluctuating
* Shut Down Engine Required
MAX VIBRATION LEVEL

LAST OPPORTUNITY TO SHUT DOWN - PRIOR TO CATASTROPHIC ENGINE FAILURE & AIRCRAFT DAMA[illegible]

TURBINE O/HEAT — EGT RISES RAPID[illegible] TO MAXIMUM DUE T[illegible] SOME FUEL PROBABLY STILL SUPPLYING ENGINE

DISC FAILURE
PYLON O/HEAT
H2. BANGS
CAPT. SELECTS [illegible]

(NO GRAPH FOR FUEL FLOW IN PREL. REPORT.)

WINDOW OF OPPORTUNITY 12 SECS. FOR ENGINE SHUT DOWN. BEFORE DISC. FAILURE

March, 1st 2011.

SUBMISSION TO THE SENATE ENQUIRY INTO AIRLINE SAFETY.

PLEASE READ FIRSTLY THE COPY OF MY SUBMISSION TO THE ATSB REGARDING THE QANTAS A380 ENGINE DISC EXPLOSION OUT OF SINGAPORE ON NOVEMBER 4TH 2010. (ENCL)

The A380 was reported in the Australian Aviation Magazine of Jan/Feb 2011 – this "Catastrophic Uncontained failure was almost of Titanic Scale". The aircraft was clearly saved from a similar fate to that of the Titanic.
It is very early days in the investigation by ATSB and other aviation bodies throughout the world.

Apart from the apparent lack of Crew corrective action, to the # 2 engine prior to the disc failure, a possible explosive situation developed. After the disc failure fuel half a meter wide was reported by the Second Officer to be flowing from the vicinity of the # 2 engine. At the time of the disc failure the E.G.T. (exhaust gas temperature) was at least 950 degrees centigrade, and may well have ignited this fuel if contact between the two had been made.

HISTORY LEADING TO CHANGEOVER TO 2 CREW OPERATION.

As early as 1960s, airline companies and manufacturers agreed to remove Flight Engineers from all future planned large passenger aircraft. Flight Engineers, they insisted, were an "UNNECESSARY LUXURY THEY COULD NO LONGER AFFORD". All future aircraft would be designed with a Crew of 2 Pilots only, with additional automatic systems to facilitate a 2 crew operation.

These were the days of the B707, Lockheed Electra, B727 aircraft, all carrying a Flight Engineer. The DC9 was about to be introduced, and the Australian Federation of Air Pilots had demanded that Flight Engineers be included in the Crew of all future large passenger aircraft including the DC9. The two parties were judged to be in dispute.

In November 1967 Professor Isaacs was installed as a Tribunal to make a binding decision on the DC9 crew compliment. The companies and the AFAP presented their arguments. His judgment was given in August 1969 in favour of the airlinecompanies, thus determining a two crew only DC9 cockpit. This decision effectively spelt the death knell of the Flight Engineer into the future in Australia.

The B747-100/200/300 series, B727-100/2 series and A300 aircraft (B767 for a period at Ansett) continued to operate with 2 Pilots and a Flight Engineer.
The B747-300 became the last of the major Australian aircraft to carry a Flight Engineer being replaced by 2 crew aircraft as they became available – e.g. B747-400, A330, B767, A380 – on the domestic scene the B737, A320, and A330 replaced the B727 and A300.

The Ansett B767 was crewed with a Flight Engineer for a short period, prior to the Crew being reduced to 2 Pilots. The Ansett B767 aircraft were later withdrawn from service by order of the Government Regulator due to the continued operation of the aircraft with unserviceable Emergency Exits immediately prior to the busy Easter period, and the resulting rapid demise of the company.

From Media Reports the Qantas B747-400 has had a bad run in recent years with at least six in-flight engine failure emergencies in the last twelve months, one of which (returned to SFO on 30.8.2010) was reported as not contained within the cowling; Two others provided passengers with a sight of exhaust fires (30.3.2010 return to SYD and 5.11.2010 return to SIN) and another reported by the Captain as having "COOKED ITSELF" (15.1.2011 return to SYD). The other two returned to land in Bangkok (6.4.2010 and 11.1.2011).

These failures follow engine failures in previous B747-400 years, together with other serious emergencies –

1. **An oxygen bottle explosion – piercing and entering the passenger cabin from the cargo compartment, before smashing through the fuselage to be lost over board – 25.7.2008.**

2. **Loss of most electrical power approaching Bangkok due to water draining from the Buffet into the Electrical Compartment – 7.1.2008.**

3. **Over-run of the runway in wet conditions in Bangkok due to "unsafe acts and active failures" (as contained in the ATSB report of April 2001) by the Flight Crew resulting in severe damage to the aircraft – 23.9.1999 (copy of report pages attached).**

Engine failures are usually traced to some sudden or developing fault. In the A380 case the fault developed quickly due to the failure of an oil line. Other failures, of course, occur for a variety of reasons. Engine failures will continue to occur from time to time. Early Crew Recognition of faults must be an ABSOLUTE PRIORITY IN ORDER TO REDUCE THE NUMBER OF ENGINES THAT UNNECESSARILY PROGRESS ON TO A STATE OF SEVERE UNCONTROLLABLE FAILURE.

The lead up to the A380 engine failure reminds me of the 747 over run in Bangkok (in 3 above) attributed in the ATSB report to "unsafe acts and active failures" on the part of the Crew. (I enclose photocopy of my rough, not to scale, landing chart of that event). The Second Officer position was also discussed in the report and the report drew attention to the lack of assistance given to the other Crew Members at vital moments.

As an ex Flight Engineer, now looking on, many incidents appear to have taken place that I believe would not have occurred had a Flight Engineer been a part of the Crew.

Two most critical and very expensive events were -

1. As detailed in the ATSB report of April, 2001 concerning the runway overrun by B747-400 in Bangkok, resulting in severe damage to the aircraft, September,1999. (Copies attached)

2. A 12 second period of flight immediately before the A380 No. 2 engine disc failure tore through the cowl severely damaging the aircraft and leading to multiple extreme ongoing flight and landing difficulties for the Crew. The interim report appears to make no mention of any Crew reference to the engine during that 12 second period.

We must wait till the A380 ATSB final report before we hear the verdict (maybe up to 18 months) on the conduct of the Crew involved, (5 in total) and what emphasis they give to the role of the Second Officer (if able to be in a position to monitor the failing engine, given the two extra Pilots reportedly in the cockpit).

You will no doubt realize the main thrust of my using as examples the two most serious and expensive Qantas accidents in recent times (i.e. A380 Singapore, Nov 2010, and B747-400 Bangkok Sept 1999) is to illustrate my certainty that neither catastrophe would have occurred if a dedicated Flight Engineer had been part of the Crew.

THE SECOND OFFICER

Not a replacement for the Flight Engineer.
A Junior Pilot in training – waiting to be a First Officer.
Not an integrated Crew Member.
Not always part of the Crew (long haul crew member only, primarily for Crew rest purposes).
Main interest in the cockpit - flight instruments and various other flight situations.

SECOND OFFICER (cont)

Has NOT been trained to take over Flight Engineer duties, in particular close monitoring of systems. This is vitally important during take off and landing and in other changes to the flight's profile.

Trans Australia Airlines flirted with the idea of turning Junior Pilots into Flight Engineers. After receiving normal Pilot/Engineering training on the type, they were cleared to train as a Flight Engineer. The trial was a disaster and eventually abandoned. They showed little interest in developing Flight Engineer skills, as their attention was often distracted by Pilot only procedures. Their ambition was to be a Pilot – not a Flight Engineer.

<u>YOU MAY ASK - AS OTHERS OFTEN DO - WHAT DOES/DID A FLIGHT ENGINEER DO?</u>

Experienced Aircraft Engineers were selected to add to Crews of all larger International and Domestic aircraft in the 1950s and early 1960s. Flight Engineers were trained and licensed as fully integrated Crew members, together with their own dedicated check and training personnel.

BRIEFLY, SOME OF THE FLIGHT ENGINEER DUTIES.

1. Check, monitor, advise, control systems as necessary in flight and on the ground, and report problems to the Captain, First Officer and ground Engineers.

2. Record engine and system parameters at regular intervals throughout flight in order to facilitate recognition of short and long term variations.

3. Check operation of all possible systems, quantities (fuel, oils, oxygen etc) prior to flight – carried out while Pilots are briefed for en- route weather and whilst route planning.

4. Keep a log of fuel used, and remaining, throughout flight in case of failure to fuel indication systems. Fuel used can be calculated from charts if necessary.

5. Prior to flight inspect external aircraft components – engine cowls, wheels and tyres, external in- flight sensing devices, airfoil surfaces, fuselage damage etc., cabin emergency equipment, emergency exits and doors, general passenger cabin condition.

FLIGHT ENGINEER (cont)

6. **Monitor transmissions to and from ground control. Contact company agent on approach, and advise of any requirements.**

7. **Prepare maintenance log advising ground engineers of flight problems and perceived potential problems.**

8. **Check correct fuel has been loaded and check fuel quality. Check aircraft load and trim requirements before take-off.**

The Flight Engineer was often used as an extra source of technical advice (to Pilot Crew in flight and on the ground). This function was from time to time requested during long flights and regularly during Simulator Programmes and briefings.

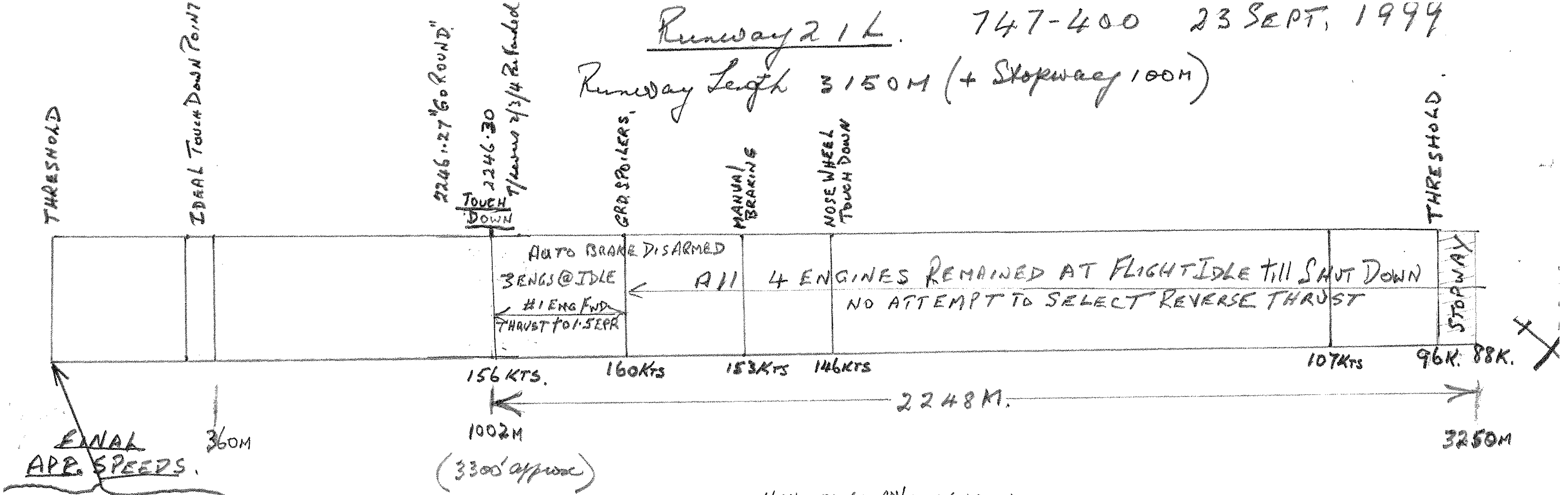
Sixteen years after my retirement, I still hold strong views that a grave error of judgment has occurred by the withdrawal, over the last 10-20 years, of Flight Engineers from the cockpit of all large passenger aircraft.

Thank you for the opportunity to share with you my version of what I believe to be a Major Reduction in the Safe Operation of Aircraft in Australia.

George A. McArthur.

Runway 21L. 747-400 23 SEPT. 1999

Runway Length 3150M (+ Stopway 100M)



FINAL APP. SPEEDS.

ACTUAL	TARGET
169 KTS	154 KTS
76 FT	44 FT

FT. OVER THRESHOLD

Event	Time	
TOUCH DOWN – Go Round/All 4 T. LEVERS ADV.	2246:30.1	NO AUTO SPOILER
Capt. reduced #s 2, 3 + 4 to Idle	2246:31.6	#1 left at fwd thrust reached 1.50 EPR for 1.4 Secs
F/O reduced #1 " "	2246:33.0	
	22.46:33.1	AUTO SPOILER DEPLOYED (DUE NO 1 TO IDLE)
NO CREW NOTICED AUTO BRAKE DISARMED	33.3	AUTO BRAKE DISARMED (DUE #1 HAD BEEN ADVANCED)
	46:33.5	T/O CONFIG. WARNING. DUE T/Lever adv with FLAPS + SPOILER LEVER IN LDG POS
	46:38	SPEED DECREASED (START) below touch down SPEED 1625 M. from THRESHOLD.
All 4 Engines remained at Flt. Idle throughout the landing roll	46.38	MANUAL Brake Commenced.
	46:41	NOSE wheel Contacts runway.
	2247.04	A/c overran Stopway.

At no stage was Rev. Idle or increased Reverse selected.

PHOTO COPIES FROM ATSB REPORT INTO B747-400 OVERRUN BANGKOK 23. SEPT. 1999

Observations:

A low frequency of recent landings can influence a pilot's skill levels. Although both the captain and first officer had relatively low levels of recent flying in the 30 days prior to the accident, the extent to which this affected crew performance during the approach could not be reliably determined. Aside from the runway surface conditions (see observation at end of sections 1.7 and 1.9), the captain appeared to maintain a high level of situational awareness at all times during the approach. Based on this information, it is unlikely that the low level of recent flying affected his performance. However, it may have been one of the factors that contributed to the approach speed being high as the first officer manually flew the aircraft on final approach.

1.8.3 NB Second officer roles and procedures

The B747-400 aircraft was designed to be operated by two pilots (captain and first officer). Depending on the length of the sectors on a trip, additional pilots may be carried to relieve the captain and first officer during long sectors. On Qantas operations, a second officer fulfils this role on certain sectors. Second officers are not allowed to occupy either of the control positions during taxi, takeoff, landing, airborne below 3,000 ft (in visual meteorological conditions), airborne below 5,000 ft (during instrument meteorological conditions), or during an instrument approach (in instrument meteorological conditions).

The *Qantas B747-438 Operations Manual* provided no specific duties for a second officer during the approach and landing phases. In the company *Flight Administration Manual*, the following was stated (paged 4-7):

> Second Officers will draw the attention of other Flight Crew members to any particular factor that may have been overlooked by them...
>
> The Second Officer duties will be allocated by the Pilot-In-Command or First Officer. The Second Officer, whilst not included in standard crew operating procedures, is expected to monitor and assist the operation in ALL respects. The Second Officer will carry out all commands and requests as directed by the Pilot-In-Command and First Officer.
>
> B747-400 and 767 Second Officers are not to be allocated any duties that affect the integrity of two pilot standard operating procedures.

Results from the B747-400 pilot survey conducted during the investigation included the following:

- Many pilots 'strongly disagreed' (24%) or 'disagreed' (29%) that the role of the second officer is clearly specified in company documentation.
- Many pilots 'strongly agreed' (38%) or 'agreed' (32%) that the role of the second officer should be more clearly defined in the takeoff and approach/landing phases of flight.
- Many pilots 'strongly agreed' (20%) or 'agreed' (27%) that second officers are not adequately trained for their role.

Management pilots, check-and-training pilots and line pilots, commented that the level of involvement of second officers during approach and landing phases on line operations varied. In general, there was a reluctance to interfere with the two-pilot operational philosophy, and therefore a reluctance to assign key operational duties to second officers (who were not carried on all flights). Some experienced pilots commented that B747-400 second officers were generally less involved than had been the case on earlier aircraft types, on which second officers had more clearly specified duties during the approach and landing phase.

Second officers did undertake recurrent simulator training (see attachment G). This involved handling practice and pilot support from both control positions. They did not receive regular training or checks of crew performance as an additional crewmember in a non-control seat.

Observations:

Like the other two pilots, the second officer did not notice the absence of reverse thrust during the landing roll. Because Qantas B747-400 operations involve both two-pilot and three-pilot operations, it is difficult to assign specific duties to second officers during takeoff, approach and landing phases. However, the role of the second officer during these phases could be more clearly defined and reinforced in simulator training and line flying checks. Such initiatives would increase the level of effective involvement of second officers during these phases. The extent to which such initiatives might have influenced the Qantas One second officer's performance could not be determined.

1.8.4 Crew resource management

Crew resource management (CRM) is generally defined as 'the effective use of all available resources, i.e. equipment, procedures and people, to achieve safe and efficient flight operations'.[46] It is associated with principles such as communication skills, interpersonal skills, stress management, workload management, leadership and team problem-solving. These principles have been taught in major airlines since the late 1970s.

It is generally recommended that CRM programs consist of initial awareness training, recurrent awareness training, practical training exercises, and incorporation of CRM elements in normal check-and-training activities. Most Australian high-capacity operators (including Qantas) provide their flight crews with some form of CRM training. CASA currently provides no regulatory requirements or guidelines for how this training should be conducted or incorporated into check-and-training systems in Australia.[47]

A description of the Qantas CRM program is at attachment G. In summary, the program did not contain all the elements of what is currently regarded as best practice in this area.

The captain and first officer completed the Qantas initial CRM awareness course in 1989, and the second officer completed the course soon after starting line operations in 1995. Each of the flight crew had attended the annual update training since their initial course.

None of the pilots had flown together before the accident flight.[48] The flight crew reported that there were no difficulties in their relationship during the flight, and they considered, from their recollection and after listening to the CVR, that the CRM exhibited during the approach was good. A review of the CVR revealed that relationships between the crew appeared to be cordial and that crewmembers were focussing their attention on the task at hand. There were several instances of each crewmember volunteering information to the other pilots. There were also several instances of the crew identifying relevant operational issues, such as excess speed and altitude, and providing supportive behaviour. The crew reported that the weather conditions and potential options had been discussed during the

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46 ICAO, *Flight Crew Training: Cockpit Resource Management (CRM) and Line-Oriented Flight Training (LOFT)*, Circular 217-AN/132, 1992, p.4.

47 In 1995, the Bureau recommended that CASA require operators involved in multi-crew operations to ensure that pilots receive effective training in CRM principles (Interim Recommendation 950101). This recommendation was still classified as 'open' by the ATSB at the time of the accident (i.e. the ATSB had not received an appropriate response from CASA). See also section 5.5.

48 As is the case in any large airline, it is common for crews not to have flown together previously.

situation they faced. It is, therefore, unreasonable to expect the crew to have developed an adequate risk management strategy for the approach and landing.

Ideally, they should have taken the available information regarding the weather conditions and runway type (ungrooved and 'slippery when wet'), and concluded that the braking action could have been less than 'good'. They then should have considered options to deal with this situation, such as holding off until the weather improved, electing to use the other (longer) runway, or selecting an appropriate approach and landing procedure to achieve the slowest touchdown speed and shortest landing distance. The use of flaps 30 and full reverse thrust would have produced the shortest landing distance and most probably avoided the overrun.

N.B. **The first officer did not fly the aircraft accurately during the final approach.** The high approach speed, low descent rate on late final approach, and premature flare, led to the long and soft landing. Although the speed was within company limits, it was not appropriate for contaminated runway conditions. Based on the reports from many Qantas B747-400 pilots, the speed exceedance (and the extent of the 'long' landing) was much less likely to have occurred if a flaps 30 configuration had been used. The slightly steeper than normal glideslope was a relatively unusual situation, and may have made a minor contribution to the excessive speed on final approach. The first officer's level of currency may also have contributed.

The reduction in the descent rate when the heavy rain was encountered appears to have been a response by the first officer to the reduction in visibility and the distractions of the rain and windscreen wipers. The subsequent runway aimpoint control problems (e.g. early landing flare) were probably the result of degraded visual cues due to the presence of the rain on the windscreen and absence of touchdown zone lighting.[50]

It could be argued that the captain should have taken over control from the first officer during the final approach, or ordered a go-around earlier. However, the captain was continually monitoring the situation, and was satisfied that the visual conditions were adequate. The captain was also actively assisting and communicating with the first officer during this critical phase, and was satisfied that the progress of the approach was within company limits and adequate in terms of landing distance until he made the decision to go around. It is likely that the actual aircraft performance (such as speed and glideslope) would have had far greater prominence in the minds of the crew had they had appropriate awareness of wet/contaminated runway operations. In the event, they continued with the approach, without the captain taking over, on the faulty assumption that potential runway conditions were of no significance.

N.B. **The captain cancelled the go-around decision by retarding the thrust levers.** It is very widely accepted that a decision to conduct a go-around should not be reversed. In this case, the cancellation action had a number of side-effects. It resulted in excess thrust after touchdown, a slight delay in spoiler deployment, cancellation of the auto-brakes (due to the number 1 thrust level being advanced for more than 3 seconds), and increased workload and confusion amongst the other crew members. This confusion resulted in reverse thrust

[50] The Qantas One and Qantas 15 crews reported that they did not see the rain, or experience any reduction in their ability to see the runway lights, until they entered the rain. This indicated that the reduced visibility occurred due to a buildup of water on the windscreen, rather than the actual rain itself. Chemical rain repellent on windscreens is used by some operators to assist with visibility during heavy rain. However, reports on its effectiveness varied. Qantas ceased using the repellent and deactivated the rain repellent systems in its B747 aircraft in 1996. The repellent system used chemicals that contained chlorofluorocarbons and a world wide ban on the non-essential use and purchase of such chemicals was introduced.

not being selected (see below). This confusion may have been lessened had the captain taken control of the aircraft at this stage, or provided clearer instructions regarding his intentions.

The captain's rejection of the go-around appeared to be a considered but rapid response to a unique situation. The fact that the aircraft had touched down, and visibility had suddenly improved, removed the initial reasons for going around. The touchdown clearly acted as a prompt. However, the response time did not indicate that the captain's response was a purely reflex action. In addition, the captain had previously conducted a significant amount of base training. During such training, it is not unusual for the training pilot to override the flying pilot's actions if difficulties are being encountered at critical phases of flight. This previous experience probably increased the likelihood of the captain retarding the thrust levers in this high workload situation (and without making any comment regarding his actions).

N.B. **The flight crew did not select (or notice the absence of) idle reverse thrust.** The crew intended to use the company's normal landing configuration, which included the use of idle reverse thrust. The use of idle reverse thrust (with flaps 25) would have reduced the landing distance, and the magnitude of the accident, but would not have prevented the overrun (based on table 6). However, if the first officer had selected idle reverse thrust and kept his hand on the reverse thrust levers, it is more likely that he would have selected full reverse thrust during the landing roll.

The omission of idle reverse thrust was a direct result of the confusion that occurred after the captain retarded the thrust levers. The first officer's normal action sequence was disrupted, and he may have unconsciously substituted the action of retarding the number 1 thrust lever for the initiation of idle reverse thrust. The failure of the crew to detect this omission during the landing roll was due to high workload and confusion[51] which led to their attention being focused towards stopping the aircraft by applying the wheelbrakes. The sound of rain, wipers and other noises such as the takeoff configuration warning could have added to the workload and confusion.

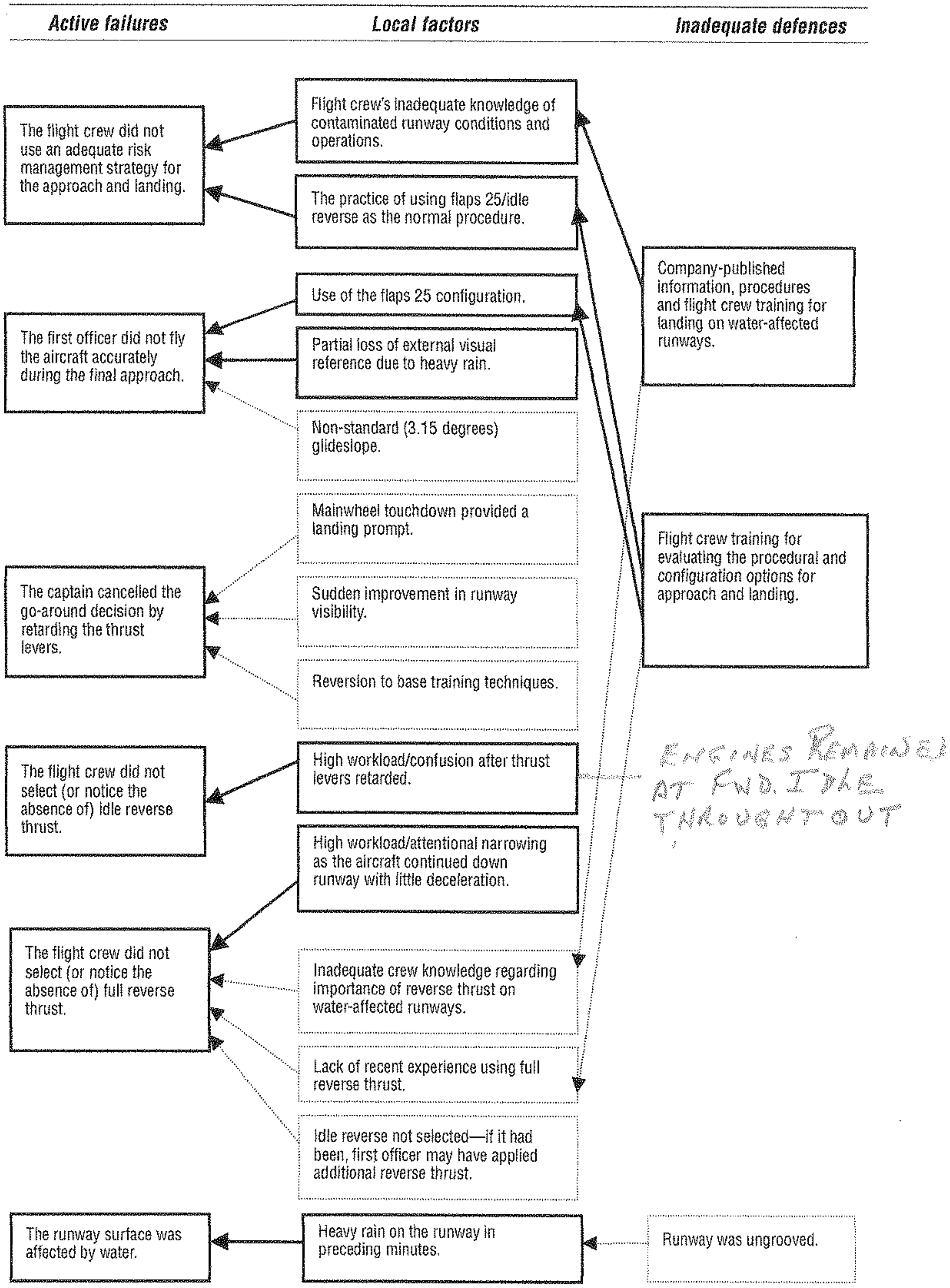
The flight crew did not select (or notice the absence of) full reverse thrust. As discussed in section 1.5, the use of full reverse thrust would have substantially reduced the landing distance on a runway with poor braking action. The failure of the crew to consider the use of full reverse thrust during the landing roll appeared to be primarily due to the high workload they were experiencing. Had the crew received more training in the importance of reverse thrust on water-affected runways, or recent experience in the use of reverse thrust, it is reasonable to expect that the crew's awareness of the importance of reverse thrust (and therefore the likelihood of them selecting full reverse thrust) would have been greater.

The runway surface was affected by water. As discussed in section 1.5, it is clear that there was sufficient water on the runway to affect braking action. However, the actual depth of water could not be determined. Indirectly, it is reasonable to conclude that if the runway had been grooved, there may have been better drainage of the runway surface. However, given the witness reports concerning very heavy rainfall in the period immediately before the aircraft landed, it does not automatically follow that grooving would have prevented the water accumulation.

51. [51] * During interviews, several company training pilots noted that omission of reverse thrust was not uncommon when distractions occurred during landing or when high workload or inexperience on type were present.

* I have been present on numerous occasions (as many F/E's would have been) when this situation occured, The F/E would immediately call "Select Reverse". This was common on Simulator Training, but also happened from time to time when bad weather existed.

Figure 5:
Summary of the active failures, local factors and inadequate defences associated with the accident flight (significant factors are in fully enclosed boxes)



6. CONCLUSIONS

6.1 Significant active failures

Parts 1 to 4 identified several unsafe acts and active failures that had a significant influence on the development of the accident. These were:

- The flight crew did not use an adequate risk management strategy for the approach and landing.
- The first officer did not fly the aircraft accurately during final approach.
- The captain cancelled the go-around decision by retarding the thrust levers.
- The flight crew did not select (or notice the absence of) idle reverse thrust.
- The flight crew did not select (or notice the absence of) full reverse thrust.
- The flight crew did not consider all relevant issues when deciding not to conduct an immediate evacuation.
- Some crewmembers did not communicate important information during the emergency period.

Other significant active failures were:

- The runway surface was affected by water.
- The cabin interphone and passenger address system became inoperable.

6.2 Significant latent failures

Significant latent failures associated with Qantas Flight Operations Branch activities were:

- Company-published information, procedures, and flight crew training for landing on water-affected runways were deficient.
- Flight crew training in evaluating the procedural and configuration options for approach and landing was deficient.
- Procedures and training for flight crew in evaluating whether or not to conduct an emergency evacuation were deficient.
- Procedures and training for cabin crew in identifying and communicating relevant information during an emergency were deficient.
- The processes for identifying hazards were primarily reactive and informal, rather than proactive and systematic.
- The processes to assess the risks associated with identified hazards were deficient.
- The processes to manage the development, introduction and evaluation of changes to operations were deficient.
- The design of operational procedures and training were over-reliant on the decision-making ability of company flight crew and cabin crew and did not place adequate emphasis on structured processes.
- Management culture was over-reliant on personal experience and did not place adequate emphasis on structured processes, available expertise, management training, and research and development when making strategic decisions.