

KNR – Asset Integrity Management



AGENDA

- Overview of KNR
- Evolution of asset integrity management at KNR
- Piping integrity review
- RMS database
- Structural Integrity at KNR

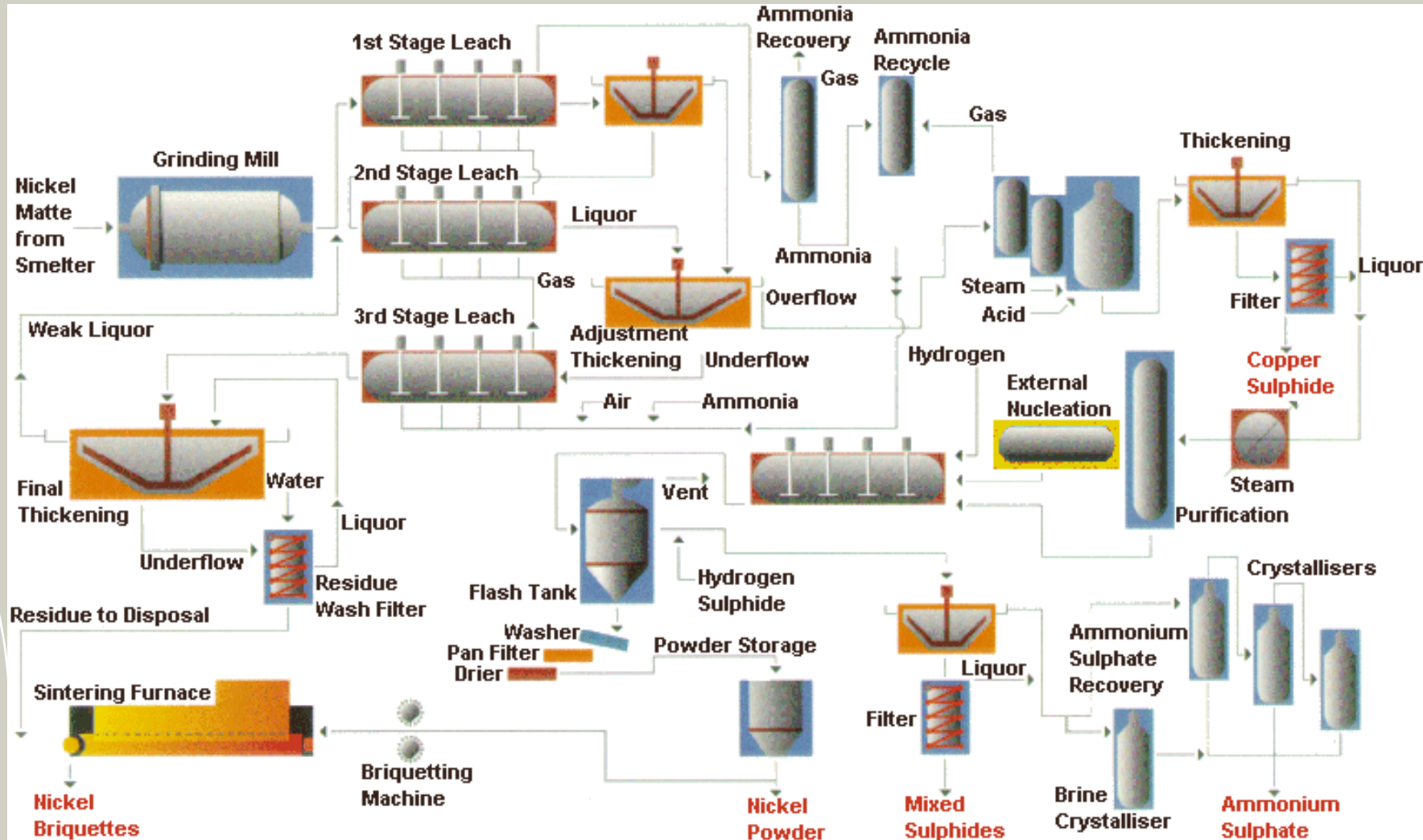


OVERVIEW

- Located in Kwinana, the refinery produces high purity nickel briquettes and powder. Commissioned in 1970, this facility receives nickel-in-matte (which contains about 68 per cent nickel) from BHPBilliton smelter at Kalgoorlie, and refines it to near-pure nickel. KNR produce approximately 61,000 tonnes of nickel metal annually. It also produces intermediate products including nickel-cobalt sulphide, copper sulphide and ammonium sulphate



KNR – Asset Integrity Management





HISTORY

- Single stand alone database for management of registered vessels – commenced in the early 1990's
- Single stand alone database for management of tanks – commenced use in the late 1990's
- In 2002 kicked off a process to review piping integrity



PIPING INTEGRITY REVIEW (2002)

The Mission

“Ensure pipe failures which impact on Safety, Environment and Production are eliminated”

The Outcome

- A prioritised list and scope, based on risk ranking
- A fully risk ranked list of all piping systems
- A list of low risk piping that does not require testing.
- Resourced and costed scope for testing

KNR – Asset Integrity Management



Process	System	Risk ranking.	Likelihood A,B,C,D,E	Likelihood Comment	Consequence 1-5	Consequence Comment	Operating Pressure kPa	Operating Temperature Deg C	Gas/Liquor
REDUCTION	PROCESS WATER	8	C	HAS HAPPENED	2	ONLY WATER CONTROLLABLE	700	35	L
H2 AREA	INSTRUMENT AIR	8	C	HAS HAPPENED	2	MAY STOP PLANT	700	A	G
	COOLING WATER SUPPLY	8	C	HAS HAPPENED	2		800	A	L
	COOLING WATER RETURN	8	C	HAS HAPPENED	2		800	100	L
	POWDER ADDITION	9	D	HAS NOT HAPPENED	3	ABRASIVE	800	100	L
	EXTERNAL NUCLEATION FEED	9	D	HAS NOT HAPPENED	3	ABRASIVE CORROSIVE	1400	80	L
	NITROGEN MP	13	C	COULD HAPPEN	3		2000	A	G
	NITROGEN HP	13	C	COULD HAPPEN	3		4200	A	G
	50LB STEAM	13	C	HAS HAPPENED	3		345	160	G
	DOSE THICKNER OVERFLOW	13	C	HAS HAPPENED	4	NH3 FUMES, EYES, ENVIRO	800	75	L
	PROCESS AIR	14	D	NOT LIKELY	4	PLANT DOWN FOR A DAY	6300	170	G
	MEDIUM AQUA	14	D	NOT LIKELY	4	NH3 FUMES, EYES	700	40	L
	SUMP DISCHARGE	17	B	OFTEN HAPPENS	3	UNKNOWN LIQUORS	700	100	L
	REDUCTION FEED LIQUOR	18	C	HAS HAPPENED SAMPLE POINTS	4	CARCINOGENIC	2400	200	L
	HP CONDENSATE	18	C	HAS HAPPENED	4	RAPID BURN	350	150	L
	750LB STEAM	18	C	HAS HAPPENED	4		5715	250	G
	HYDROGEN	18	C	COULD HAPPEN	4	EXPLOSIVE	6000	A	G
	CLAVE NICKEL DISCHARGE	18	C	SYSTEMS HAVE HAD IN PAST	4	EXPLOSIVE & ABRASIVE	3100	200	L
	METAL FREE LIQUOR	18	C	COULD HAPPEN	4		800	90	L
	CLAVE SEAL WATER	18	C	HAS HAPPENED	4	SEAL FAILURE. EXPLOSION	4500	40	L
	HYDROGEN VENT	21	B	LINES MOVE A LOT	4	EXPLOSIVE	3100	200	G
	NEUCLEATION DISCHARGE	21	B	DOES HAPPEN	4	EXPLOSIVE & ABRASIVE	3100	180	L

KNR – Asset Integrity Management



PIPING INTEGRITY REVIEW (2002)

	<i>Likelihood</i>				
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>
<i>A</i>	11	16	20	23	25
<i>B</i>	7	12	17	21	24
<i>C</i>	4	8	13	18	22
<i>D</i>	2	5	9	14	19
<i>E</i>	1	3	6	10	15



PIPING INTEGRITY REVIEW (2002)

Outcomes

- All process and systems identified

Services	169
----------	-----

Leach	227
-------	-----

Reduction	88
-----------	----

Total	486
-------	-----

- “Cut off” of 13 (RR) determined
- Independent review of systems below “Cut Off”
- 194 require scope/testing ie above “Cut Off”



CONSOLIDATION of Databases

- The outcome of the piping integrity review was a third, single, stand alone database for management of piping
- Review of commercial databases for integrity management
 - Sigpoint (Piping only)
 - IONIK consulting (HBI RBI Database, based on API 581 and applied to pressure vessels and piping)
 - RMS MPT Solutions (based on API 581 and AS 3788. Vessels, Hex, Boilers, Tanks, Piping, Relief Valves, Rotating Equipment and cranes)



STRUCTURAL INTEGRITY

- Corrosion of CS structures is a major issue at KNR
- Repair of corroded structures is very expensive
 - Class 1 Zone 1 areas repaired whilst process still operating
 - Habitats, positive ventilation, access (~70%+ of total cost)
- Assessment and repair of structures is a highly specialised discipline
- Developed a program for regular inspection and assessment by independent structural engineering consultants (~2002/3)



KNR – Asset Integrity Management

STRUCTURAL INTEGRITY

Plant Corrosion Survey

Sort field	MaintItem	MaintenancePlan	Strategy	MaintItem text	Group	Gro:	Last order	Cycle	Next Due
AMMONIA-F2	34532	28462	KNRYRN	CORROSION SURVEY,AMMONIA RECOVERY	5302	7	850949423	Three Yearly	Apr-07
BORSIG1-5	34621	28468	KNRYRN	CORROSION SURVEY, BORSIG COOLERS	5302	17	850987709	Three Yearly	Aug-04
COMPRESSOR-5	34625	28470	KNRYRN	CORROSION SURVEY, PLANT AIR	5302	18		Four Yearly	Jun-05
COOL TOWER-15	34622	28468	KNRYRN	CORROSION SURVEY,COOLING TOWER	5302	12	851009566	Four Yearly	Aug-05
FACILITIES-17	34536	28465	KNRYRN	CORROSION SURVEY,PIPERACKS (INTERJOIN)	5302	8		Four Yearly	May-05
FACILITIES-2	34534	28464	KNRYRN	CORROSION SURVEY,FILTER & SULPHIDES PACK	5302	6	850840889	Two Yearly	Feb-05
FACILITIES-2	34537	28461	KNRYRN	CORROSION SURVEY,BUILDINGS & SUBSTATIONS, Leach	5302	9		Ten Yearly	May-11
FACILITIES-32	34535	28463	KNRYRN	CORROSION SURVEY,MATTE HANDLING	5302	16	850958765	Three Yearly	May-07
FACILITIES-4	34539	28466	KNRYRN	CORROSION SURVEY, AMSUL & AMSUL STORAGE	5302	10	850908768	Two Yearly	Oct-04
FACILITIES-5	34538	28461	KNRYRN	CORROSION SURVEY,BUILDINGS & SUBSTATIONS, Services	5302	14		Ten Yearly	May-11
FACILITIES-G2	34529	28419	KNRYRN	CORROSION SURVEY,OXY & EXT NUCLEATION	5302	2	850845531	Two Yearly	May-05
FACILITIES-H2	34528	28418	KNRMNN	CORROSION SURVEY,REDUCTION & WET METALS	5302	1	850994831	Eighteen Monthly	Mar-05
FACILITIES-H2	34531	28461	KNRYRN	CORROSION SURVEY,BUILDINGS & SUBSTATIONS, Reduction	5302	5		Ten Yearly	May-11
FURNACE FACILITIES	34530	28420	KNRYRN	CORROSION SURVEY,PACKAGING AND FURNACES	5302	3	850915604	Three Yearly	Jan-07
H2 PLANT-33	34626	28471	KNRYRN	CORROSION SURVEY, HYDROGEN & PSA PLANT	5302	19		Four Yearly	Jan-05
H2S-9	34540	28467	KNRYRN	CORROSION SURVEY, HYDROGEN SULPHIDE	5302	11	850915605	Three Yearly	Jan-07
LEACH 2-B2	34533	28463	KNRYRN	CORROSION SURVEY,LEACH & THICKNERS	5302	15	850958764	Three Yearly	May-07
RO-22	34624	28468	KNRYRN	CORROSION SURVEY, STEAM & NF/RO PLANT	5302	13		Five yearly	Aug-05



STRUCTURAL INTEGRITY

 <p>Corroded bracing</p>	 <p>Corroded bracing</p>
 <p>Perforated edge beam</p>	 <p>Perforated edge beam</p>
<p>Location</p> <p>Bracing east of H2C-8D</p> <p>Nickel reduction floor edge beam next to grid 3R at EL33.995</p>	 <p>Perforated edge beam</p>
<p>Description</p> <p>Corroded bracing</p> <p>Severely corroded and perforated platform edge beam</p>	<p>Recommendation</p> <p>The perforated edge beam appears to be corroded beyond repair. Replacement of this beam is recommended.</p> <p>The corroded bracing members should be cleaned and protected (painted) to WMC specifications.</p>



STRUCTURAL INTEGRITY

- After a couple of years we have concluded that this approach is ineffective
 - Significant corrosion found a couple of months after area survey
 - Blast & Paint program was revealing significant issues again after area survey

We have learnt that

- Inspection of structures isn't easy (can't see everything from ground / floor level / walkways)
- Tactile inspection (literally at arms length / touch) is often required to detect an issue before it becomes a major issue
- We were focused on repairing and not improving
- Prioritising / risk ranking repairs is difficult
- Converting the area survey report into a meaningful workpack for repair was difficult
- Maintaining continuity of work such that a single work crew could be kept gainfully employed was also difficult
- We had a number of incidents and injuries whilst undertaking structural repairs, indicative of poor planning and inexperienced people undertaking difficult and hazardous work



STRUCTURAL INTEGRITY – Current approach

- Project Officer – Structural Integrity
 - Duties include managing safety aspects
 - Packaging and prioritising work
 - Making improvements to eliminate corrosion
- Dedicated Integrity Supervisor and crew from Maintenance Contractor
- Mtce contractor Supervisor and crew physically separated from other crews
- Propose that the blast & paint programme be scheduled and proceed the corrosion inspection
 - Scaffold
 - Hydroblast area
 - Corrosion / structural inspection
 - Structural repairs (including improvements, eliminate leaks, new materials)
 - Blast and paint



STRUCTURAL INTEGRITY – Issues

- Capturing history and reporting
- What is maintenance and what is funded from Integrity
- Eliminating leaks, spills and sources of corrosion (piping integrity)
- Life cycle cost – Carbon steel vs. Stainless at construction