ALSTOM

Intermountain Power Service Corp.
Visit to Rugby
16th to 18th of May, 2001.

Delta 1 & 2
Engineering Review

Agenda

and

those

present.

ALSTOM

Power
Steam Turbines

Those present :-

Intermountain Power Service Corp.

James Nelson – Engineering Supervisor	-	435 864 64 64

Alstom Power

Adrian Bramley, Project Manager, Rugby	-	011 44 1788 531 111
Bill Eisma, Projects Director, Richmond	-	804 763 7715
Dr Michael Von Saldern, Unit Managing Director, Rugby	-	011 44 1788 531 485
Richard Plant, Senior Engineer (Cylinders), Rugby	-	011 44 1788 531 108
Rob Cunningham, Senior Engineer (Cylinders), Rugby	-	011 44 1788 531 144
Bob Brown, Section Leader (Thermodynamics), Rugby	-	011 44 1788 531 924
Phill Kearney, Principal Engineer (Thermodynamics), Rugby	-	011 44 1788 531 977
Bob Mitchell-King, Section Leader (Dynamics), Rugby	-	011 44 1788 531 639
Tim Shurrock, Retrofit Engineering Manager, Rugby	-	011 44 1788 531 060
Phil Peel, Section Leader (Steam Path), Rugby	-	011 44 1788 531 591
Howard Warrener, Engineer (Steam Path), Rugby	-	011 44 1788 531 283
Dr Simon Hogg, Head of Aerodynamics, Rugby	-	011 44 1788 531 540
Paul Cooper, Head of Test Group, Rugby	-	011 44 1788 531 425
David Roberts, Test Engineer, Rugby	-	011 44 1788 531 106

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Registered Office:
Lindum House
11 Sewell Road, Lincoln
LN2 5RY
Registered in England No. 476835

Introductions

and

organisation

structure.

May 2001

Intermountain Power Services Corporation Design Review

Adrian Bramley

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IP7_006110

Introduction

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- Organization structure.
- Contract schedule.
- Progress report.

IP7_006111

STR Retrofit Organization

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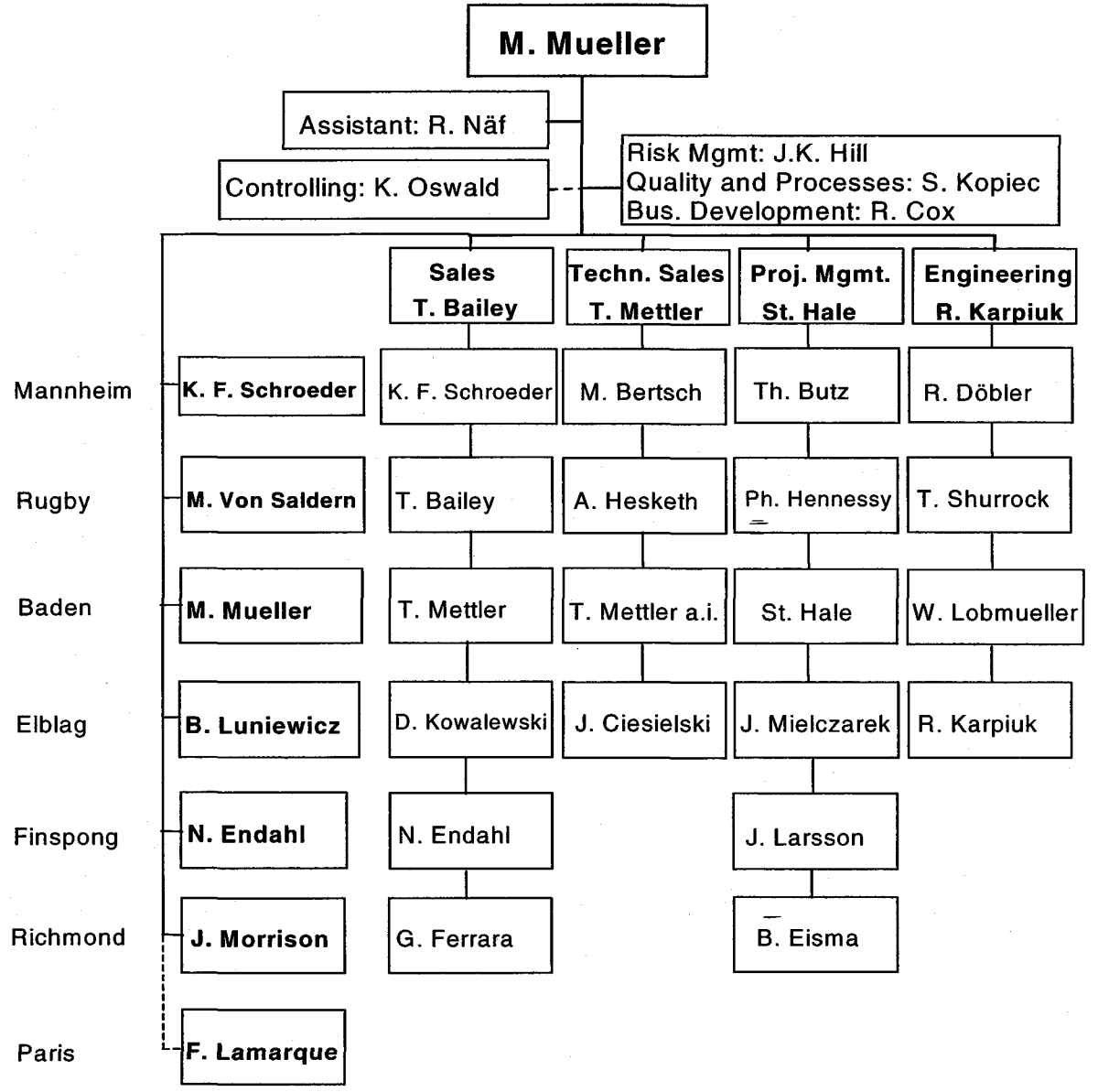

17th of May 2001

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STUU Organization

ALSTOM

Vice President
Jim Morrison

Senior Admin Assistant - M Wright
Administrative Assistant - A Seay
Admin Ass/Proposals - K McGill

Financial Controllers - B Trzyna
- B Cody

New Equipment Site Management
T.B.N.
T.B.N.

New Equipment Project Management
B. Raemy
D. Pagnotti
E. Polvi
C. Thielsch
P. Thomsen
B. Roemhild

New Equipment Sales
M. Burgess
R. Pangrazzi
E. Pickering
K. Berger

Retrofit Sales
G. Ferrara
D. Cerasoli
K. Speaks

Retrofit Project Management
B. Eisma
D. Connelly

CAES Development
W Scherer

17th of May 2001

IP7_006113

Rugby Project Team - Intermountain

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Dr Michael Von Saldern
General Manager
Rugby

Phil Hennessy
Manager
Retrofit Project Management

Retrofit Project Manager
Adrian Bramley

Department Managers

Project Team - Intermountain

Engineering Member	-	Richard Plant
Manufacturing Member	-	Stuart Dodds
Planning Member	-	Peter Matthews
Quality Member	-	Vic Donovan
Finance member	-	Tony O'Brien
Construction Member	-	TBA

17th of May 2001

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STB/Retrofits
Rugby Organisation

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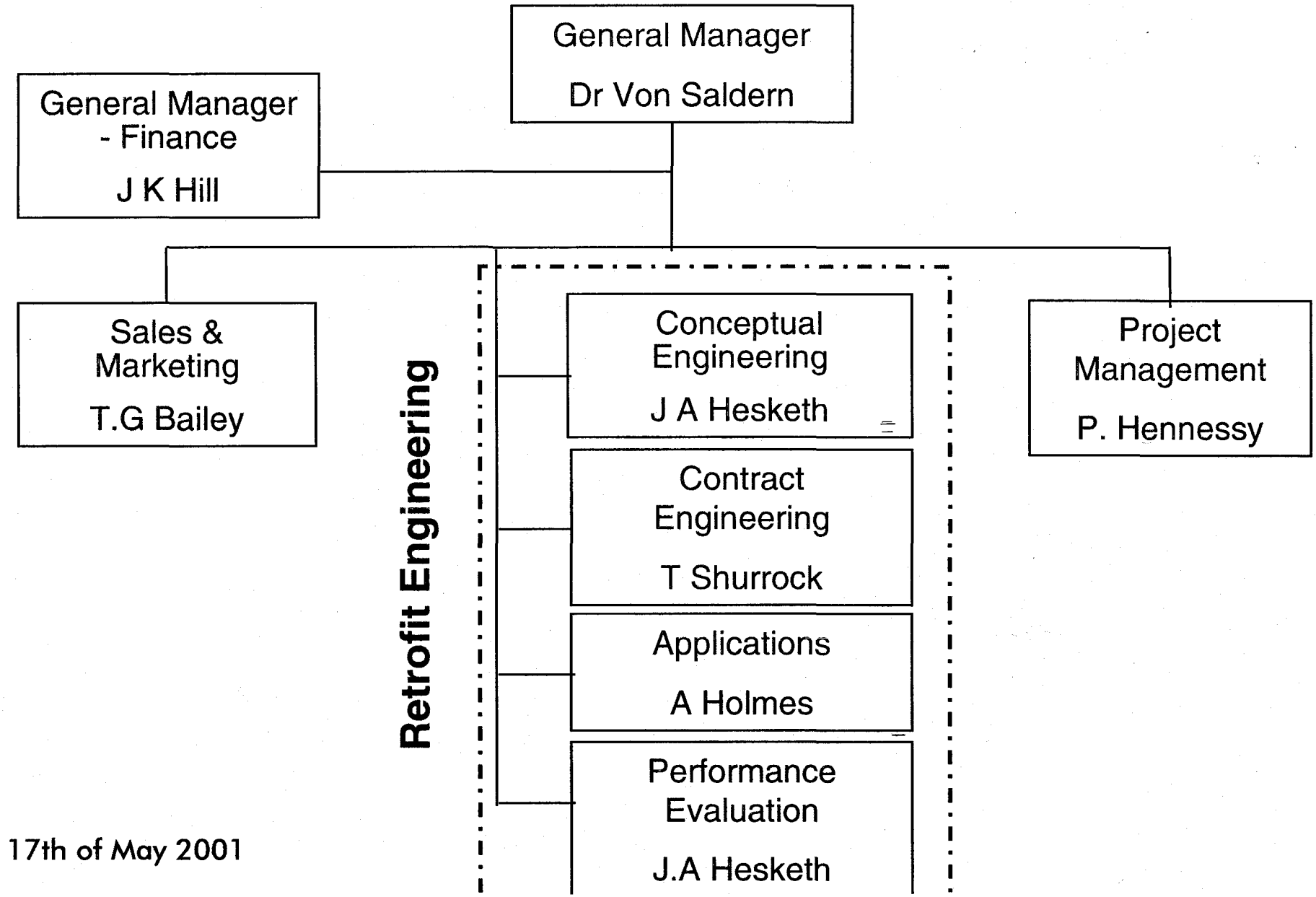

17th of May 2001

IP7_006115

Project

schedule

Unit 2 Schedule

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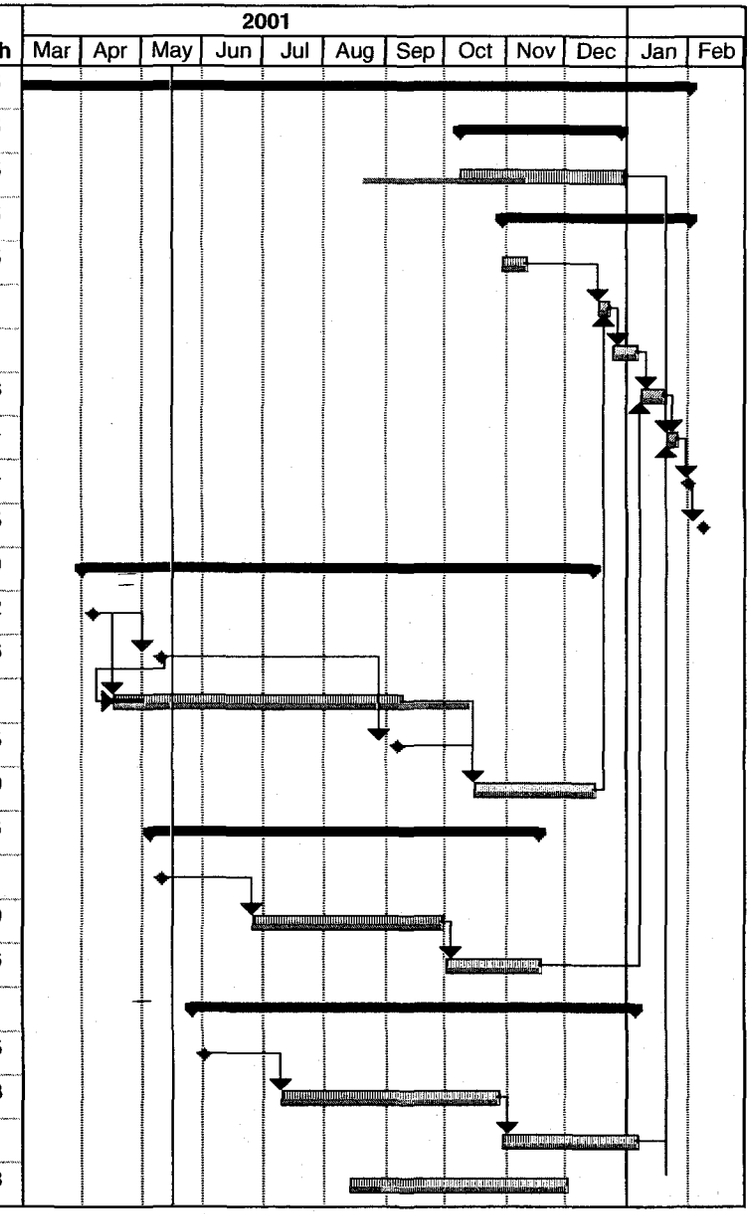
ID	RCP / BOP	Task Description	Start	Finish	B/Finish
1		**INTERMOUNTAIN 2 PROVISIONAL PROGRAMME**	**5-W08**	**5-W05**	**5-W05**
2	58BA	**HP MODULE SHIPPING FRAME**	**1-W41**	**5-W52**	**5-W45**
3		HP Module Shipping Frame - Procure & Manufacture	1-W41	5-W52	5-W45
4		**HP MODULE ASSEMBLY**	**1-W44**	**5-W05**	**5-W05**
5		HP Module Assembly - Prepare Berth	1-W44	5-W45	5-W45
6		HP Module Assembly - Prepare Casing / Set To Berth	1-W51	5-W51	5-W51
7		HP Module Assembly - Centralise Diaphragms & Glands	1-W52	5-W01	5-W01
8		HP Module Assembly - Fit Rotor & Take Boxed Leads	1-W02	5-W03	5-W03
9		HP Module Assembly - Strip Down,PFD	1-W04	5-W04	5-W04
10		HP Module Assembly - Ex-Works Target	5-W04	5-W04	5-W04
11		HP Module Assembly - Ex-Works Commitment	5-W05	5-W05	5-W05
12	A1C0	**HP INNER CASING**	**5-W13**	**5-W50**	**5-W50**
13		HP Inner - Design For Pattern	5-W13	5-W13	5-W12
14		HP Inner - Design For Casting	5-W18	5-W18	5-W16
15		HP Inner - Procure	1-W16	5-W36	5-W41
16		HP Inner - Design For M/C	5-W35	5-W35	5-W35
17		HP Inner - Machine	1-W42	5-W50	5-W50
18	A1C0	**CYLINDER BOLTING (NIMONIC)**	**5-W18**	**5-W46**	**4-W46**
19		HP Module Bolting - Design	5-W18	5-W18	5-W21
20		HP Module Bolting - Procure	1-W26	5-W39	5-W39
21		HP Module Bolting - Machine	1-W40	5-W46	5-W46
22	A1E0	**HP INLETS**	**5-W21**	**5-W01**	**5-W01**
23		HP Inlets - Design For Material	5-W21	5-W21	5-W25
24		HP Inlets - Inlets Procure	1-W28	5-W43	5-W43
25		HP Inlets - Stellite	1-W44	5-W01	5-W01
26		HP Inlets - Piston Rings	1-W33	5-W48	5-W48



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Unit 2 Schedule

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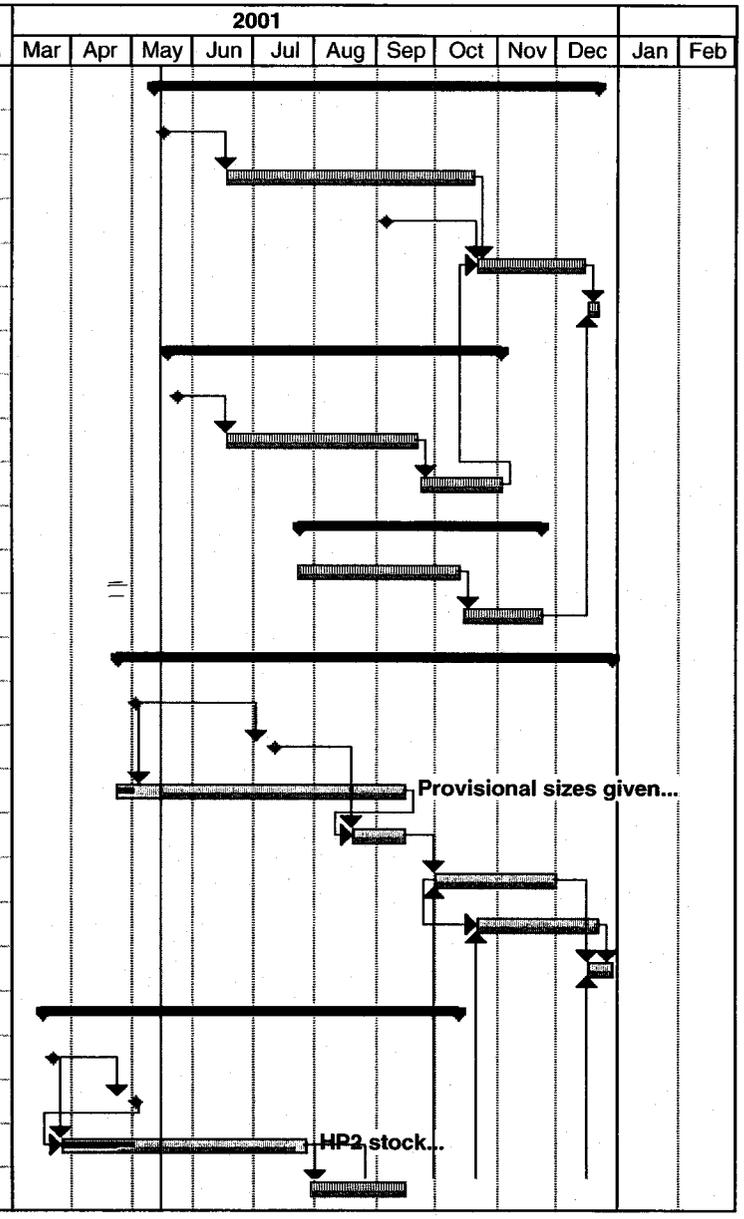
ID	RCP / BOP	Task Description	Start	Finish	B/Finish
27	A1G2	**HP INLET GLAND**	**5-W19**	**5-W51**	**5-W51**
28		HP Inlet Gland - Design For Casting	5-W19	5-W19	5-W20
29		HP Inlet Gland - Procure	1-W25	5-W42	5-W42
30		HP Inlet Gland - Design For Machining	5-W35	5-W35	5-W37
31		HP Inlet Gland - Machine	1-W43	5-W50	5-W50
32		HP Inlet Gland - SubAssy	1-W51	5-W51	5-W51
33	A1G2	**GLAND BOLTING (NIMONIC)**	**5-W20**	**5-W44**	**5-W45**
34		HP Inlet Gland Bolting - Design	5-W20	5-W20	5-W23
35		HP Inlet Gland Bolting - Procure	1-W25	5-W38	5-W38
36		HP Inlet Gland Bolting - Machine	1-W39	5-W44	5-W44
37	A1G*	**HP SHAFT GLAND RINGS (INL&EXH)**	**1-W30**	**5-W47**	**5-W50**
38		HP Shaft Gland Rings - Procure	1-W30	5-W41	5-W41
39		HP Shaft Gland Rings - Machine	1-W42	5-W47	5-W47
40	A1P*	**HP DIAPHRAGMS**	**1-W17**	**5-W52**	**5-W01**
41		HP Diaphragms - Design For Plate sizes	5-W17	5-W17	5-W18
42		HP Diaphragms - Design For Pre - M/C (Rims & Centres)	5-W27	5-W27	5-W27
43		HP Diaphragms - Procure Material	1-W17	5-W37	5-W37
44		HP/IP Diaphragms - Machine	1-W34	5-W37	5-W37
45		HP Diaphragms - Manufacture (first)	1-W40	5-W48	5-W48
46		HP Diaphragms - Manufacture (last)	1-W43	5-W51	5-W51
47		HP Diaphragms - SubAssy	1-W51	5-W52	5-W52
48	A1P*	**HP FIXED BLADES**	**5-W11**	**5-W41**	**5-W41**
49		HP Fixed Blades - Design For Procure Wt & Spec	5-W11	5-W11	5-W10
50		HP Fixed Blades - Design For Procure - Final Blade Sizes	5-W17	5-W17	5-W14
51	301910	HP Fixed Blades - Procure	1-W13	5-W30	5-W29
52		HP Fixed Blades - Machine First	1-W31	5-W37	5-W37



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Unit 2 Schedule

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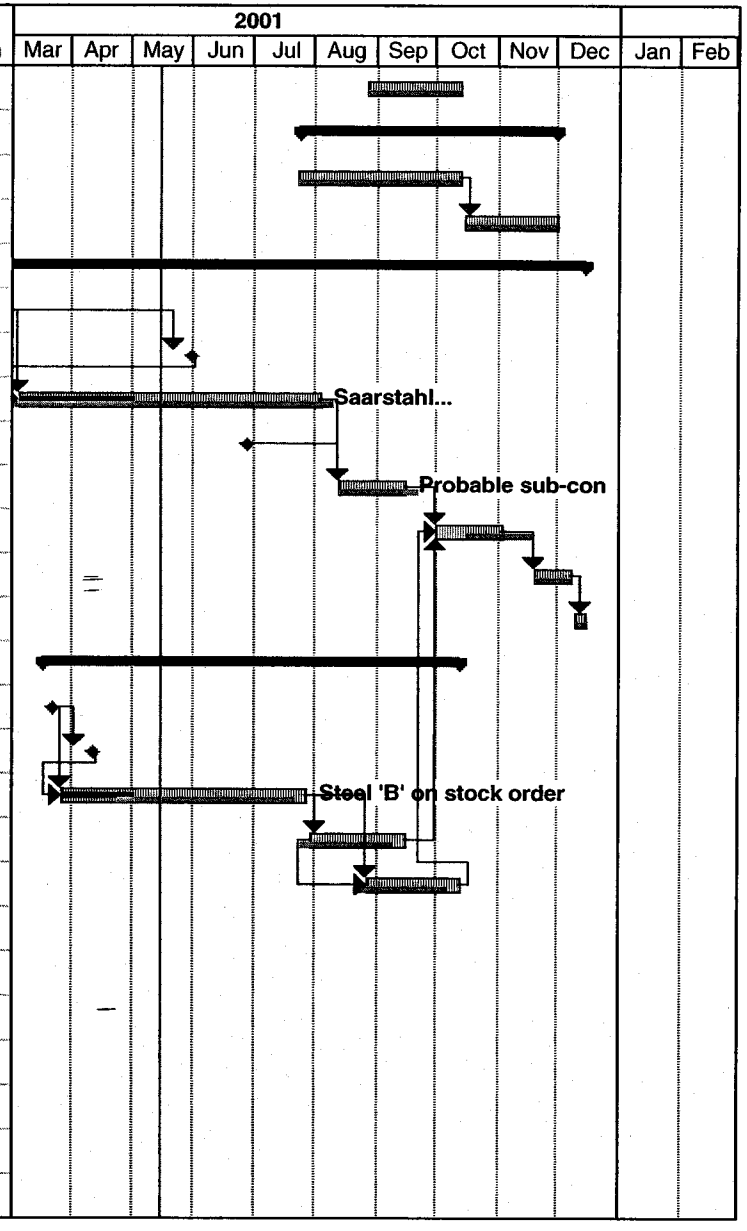
ID	RCP / BOP	Task Description	Start	Finish	B/Finish
53		HP Fixed Blades - Machine Last	1-W35	5-W41	5-W41
54	A1P*	**HP DIAPHRAGM GLAND RINGS**	**1-W30**	**5-W48**	**5-W51**
55		HP Diaph Gland Seals - Procure	1-W30	5-W41	5-W41
56		HP Diaph Gland Seals - Machine	1-W42	5-W48	5-W48
57	20038610	**HP ROTOR**	**5-W08**	**5-W50**	**5-W50**
58		HP Rotor - Design For Forging	5-W08	5-W08	5-W02
59		HP Rotor - Design For Gashing	5-W21	5-W21	5-W22
60	300946	HP Rotor - Procure Forging	1-W10	5-W31	5-W32
61		HP Rotor - Design For M/C	5-W25	5-W25	5-W27
62		HP Rotor - Pre-Blade Machine	1-W33	5-W37	5-W41
63		HP Rotor - Fit Blades & PRD	1-W40	5-W44	5-W46
64		HP Rotor - Turn Shroud.Deburr	1-W47	5-W49	5-W49
65		HP Rotor - Overspeed & PFD	1-W50	5-W50	5-W50
66	A1S*	**HP MOVING BLADES**	**5-W11**	**5-W41**	**5-W40**
67		HP Moving Blades - Design For Procure - Wt & Spec	5-W11	5-W11	5-W10
68		HP Moving Blades - Design For Procure Blade Sizes	5-W14	5-W14	5-W14
69	301878	HP Moving Blades - Procure	1-W13	5-W30	5-W29
70		HP Moving Blades - Machine first	1-W31	5-W37	5-W36
71		HP Moving Blades - Machine last	1-W35	5-W41	5-W40



IP7_006119

Thermodynamics

IP7_006120

INTERMOUNTAIN GENERATING STATION UNITS 1 & 2

HP TURBINE RETROFIT

THERMODYNAMIC DESIGN BASIS

INTERMOUNTAIN GENERATING STATION UNITS 1 & 2

HP TURBINE RETROFIT

PERFORMANCE GUARANTEE

HP TURBINE EFFICIENCY
NOT LESS THAN 92.2%

(INCLUDING VALVES WITH 3% PRESSURE DROP AND INTERNAL GLAND LEAKAGE FLOW)

For Information:
HP Efficiency Excluding Valves = 94.0%

The current level of efficiency is 87 %

Hence efficiency improvement is approximately 5%

INTERMOUNTAIN GENERATING STATION UNITS 1 & 2

HP TURBINE RETROFIT

Either a

CAPACITY GUARANTEE

HP TURBINE CAPACITY
NOT LESS THAN 6,900,000 lb/h
NOT MORE THAN 6,975,000 lb/h

Or an

HP SHAFT POWER GUARANTEE

UNIT 1 : 300.7 MW
UNIT 2 : 299.0 MW

INTERMOUNTAIN GENERATING STATION UNITS 1 & 2

HP TURBINE RETROFIT

For Guarantees of HP Turbine Efficiency and HP Shaft Power

Measurements required

1. Main steam pressure at HP stop valve chest inlet.
2. Main steam temperature at HP stop valve chest inlet.
3. After throttle valve pressure at HP turbine inlet end of steam leads.
4. IP rotor cooling steam flow (and pressure, temperature).
5. HP extraction to heater 8 – pressure.
6. HP extraction to heater 8 – temperature.
7. HP exhaust pressure.
8. HP exhaust temperature.

9. Feedwater flow to economiser.
10. Heater 8A & 8B feedwater inlet temperatures.
11. Heater 8A & 8B drain temperatures.
12. Heater 8A & 8B feedwater outlet temperatures.
13. Final feedwater temperature (common).
14. HP valves spindle leakage flows.
15. Superheater spraywater flow.

Full cycle isolation required for determination of boiler flow losses.

Test Correction Factors Probably Required

Main steam pressure
Main steam temperature
HP valve pressure drop
Extraction flow to IP rotor cooling
Extraction flow to heater 8
HP exhaust pressure

} complex - all inter-related !

INTERMOUNTAIN GENERATING STATION UNITS 1 & 2

HP TURBINE RETROFIT

For Guarantees of HP Turbine Efficiency and Swallowing Capacity

Measurements required

1. Main steam pressure at HP stop valve chest inlet.
2. Main steam temperature at HP stop valve chest inlet.
3. After throttle valve pressure at HP turbine inlet end of steam leads.
4. HP exhaust pressure.
5. HP exhaust temperature.

6. Feedwater flow to economiser.
7. HP valves spindle leakage flows.
8. Superheater spraywater flow

Full cycle isolation required for determination of boiler flow losses.

Test Correction Factors Probably Required

Main steam pressure
Main steam temperature
HP valve pressure drop
} for flow only – simple factors.

INTERMOUNTAIN GENERATING STATION UNITS 1 & 2

HP TURBINE RETROFIT

BASIS FOR DESIGN

VALVES WIDE OPEN

	Retrofit Design	Unit 1 BMCR Test	Unit 2 BMCR Test
MAIN STEAM PRESSURE	2400 psig	2520 psig	2520 psig
MAIN STEAM TEMPERATURE	1000°F	1005°F	995°F
MAIN STEAM FLOW	6.90 Mlb/h	6.75 Mlb/h	6.79 Mlb/h
HP EXHAUST PRESSURE	620.8 psia Unit 1 629.0 psia Unit 2	604 psia	618 psia
EXTRACTION PRESSURE	1089.3 psia Unit 1 1095.8 psia Unit 2	Figure 4 – Unit 2 Operating Heat Balance (Corr Test) 1091.2 psia	

HP Valves pressure drop = 3.0%
(Stop valve inlet to HP turbine inlet)

DERIVED FROM IPSC DATA

Extraction pressure
HP exhaust pressure

INTERMOUNTAIN GENERATING STATION UNITS 1 & 2

HP TURBINE RETROFIT

TURBINE CONFIGURATION

- "LOW ROOT REACTION" DESIGN

HP TURBINE

- SINGLE FLOW
- FULL ARC ADMISSION
- 8 STAGES
- EXTRACTION AFTER STAGE 5

MOVING BLADING

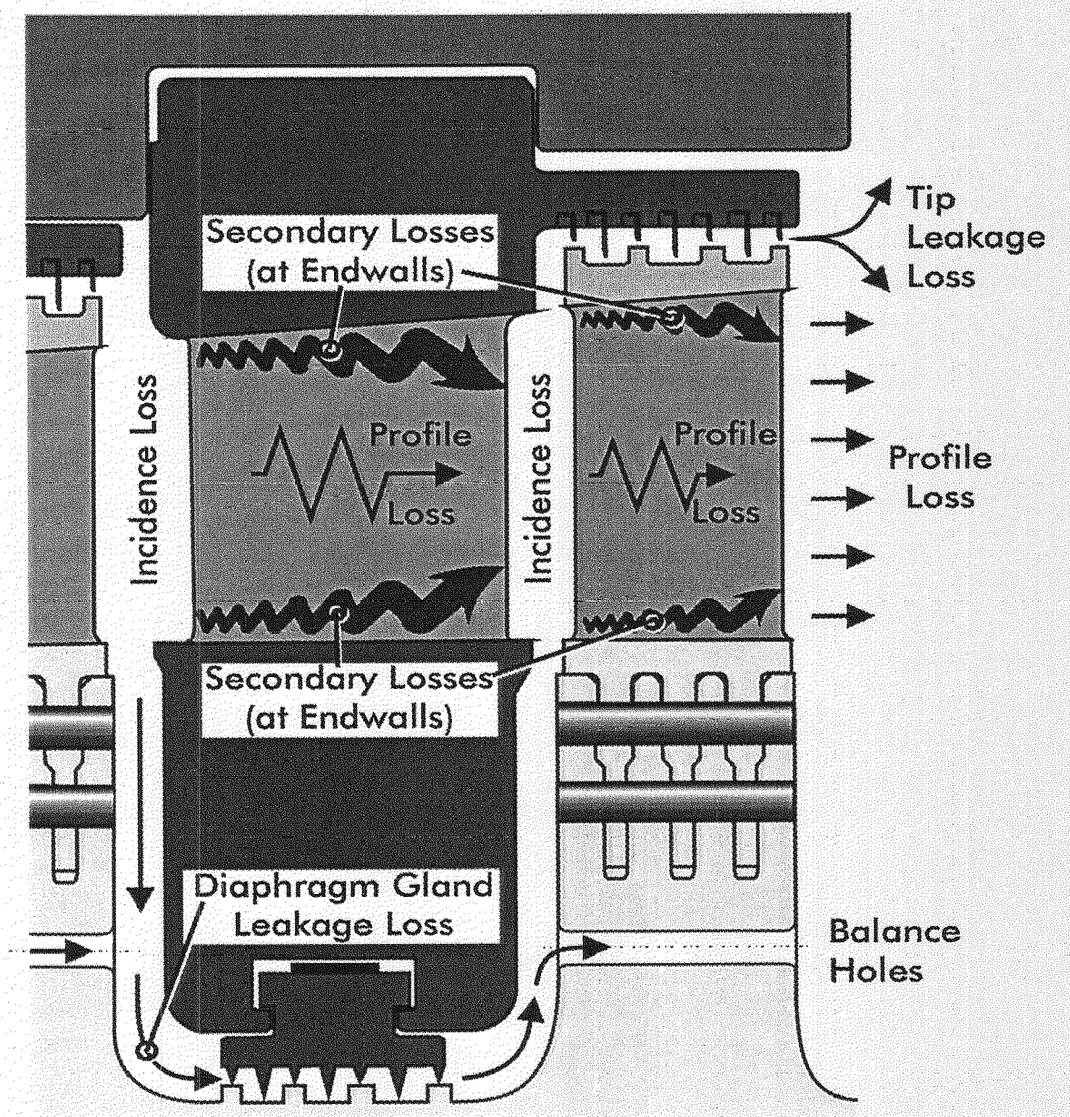
- ADVANCED PROFILE
- INTEGRAL SHROUD

FIXED BLADING

- ADVANCED PROFILES

INTERMOUNTAIN GENERATING STATION UNITS 1 & 2

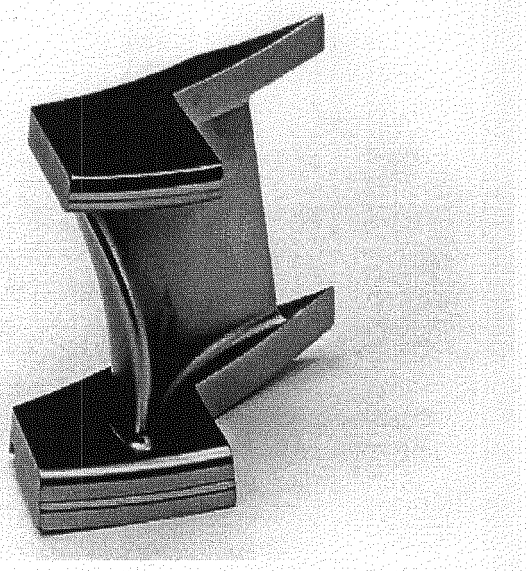
HP TURBINE RETROFIT



Sources of Efficiency Loss in a Typical Low Reaction Turbine Stage

INTERMOUNTAIN GENERATING STATION UNITS 1 & 2

HP TURBINE RETROFIT

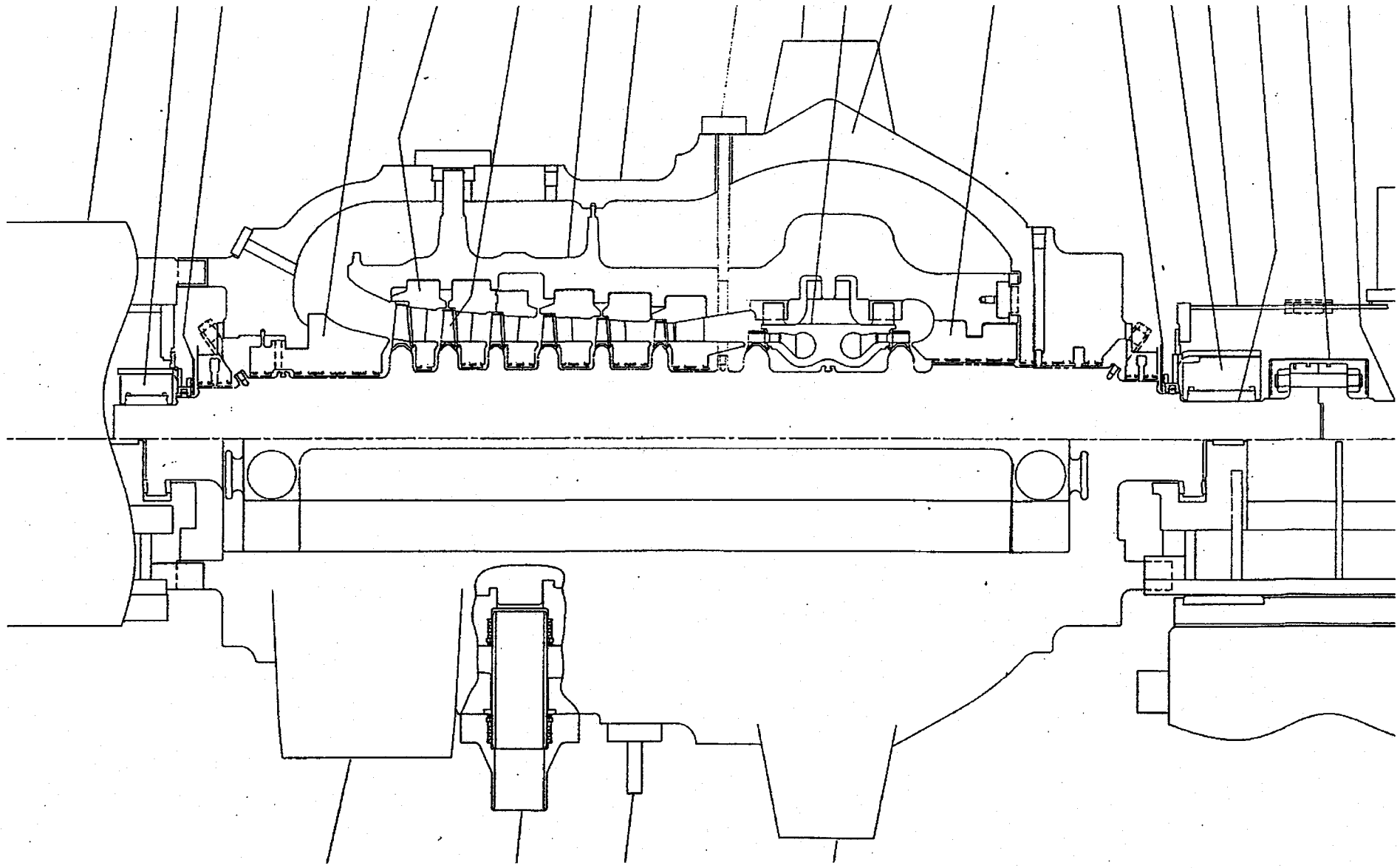


Advanced 3-D Fixed Blade

Modern Rotating Blade with Pinned Root and Integral Shroud

INTERMOUNTAIN GENERATING STATION UNITS 1 & 2

HP TURBINE RETROFIT



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